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CIVIL ENGINEERING.

On the Strength of Wood and Cast Iron.

Sir,—I had intended to lay before the Mechanical Section of the British Association for the Advancement of Science, at their late meeting at Cambridge, a few remarks on some important points connected with the Experimental Determination of the Strength of Wood and Cast Iron. The fewness of those who attended that Section rendered it advisable to forego this intention; and in fact, by mistake, my paper was described as "On the Strength of Iron Castings," which was not my main object, but merely incidental to the other inquiry "On the Strength of Timber." However, though the meeting of the Section was a failure, I of course met there with Mr. Eaton Hodgkinson, whose labors in the cause of science are so well known, and we had some short conversation on the subject of Cast Iron. He informed me that he had now preparing for publication a great mass of experimental results which would contain results bearing on my views. As, however, it may be some time before we are favored with these tables, and my object is to address the practical man rather than the scientific, I will trouble you to notice the point I wished should be attended to. It was suggested by Mr. Edward Bell, the Professor of Machinery in our College, that by increasing the length of runner head, the strength of a horizontal bar might be made equal to that of a vertical bar, and would be much more uniform in its texture. He therefore prepared some bars for determining experimentally the advantage —and found that it was as he had apprehended. The reason of course is obvious. The iron when in a fluid state obeys the laws of hydro-

statics, and the pressure increases with the depth, and a very small vertical column of iron will produce a great pressure throughout the liquid mass, a pressure proportional to its height. If, then, the column is kept in a state of fusion while the metal in the flask is cooling and setting, the particles will be packed more closely together, the density will be increased, and a stronger bar obtained. In an economical view this is very important, for a very inferior iron will by this means give as strong a bar, or stronger, than a much better, and therefore dearer, iron.

Experiments have been made only on a small scale as yet, but we purpose to extend them in number so as to generalize on the subject, and ascertain whether, by a proper depth of runner head, we cannot make bars of a mixture of Gartsberrie II. and old fire-bars of the worst scrap iron which shall be as strong as the best irons will give.

I had hoped that I should have had time to write a short account of the researches we have made on the strength of timber, but I have found it impossible for the present,—I will only draw your attention to this point. In ascertaining the strength of timber, these two points must be kept quite distinct, viz: the constant expressing the *relative strength*, and the constant to be used in the formulæ, such as those given in Turnbull, which we may call the constant representing the absolute strength.

If a hundred experiments are made on a particular kind of fir, the breaking weight in each case being taken under exactly similar circumstances, the 100th part of the sum of all these weights represents fairly enough the mean strength of that particular wood, *i. e.*, it will do to compare with a number determined in the same way for another kind of fir, and the greater this *mean* weight is, the stronger the wood. So far, then, as scientific research is concerned, this method is fair,—but the same constant will not do for the practical man. I say that for this we must take the *least* weight that broke the beam, and not the mean,—for the workman wants to know not what the average strength of the wood is, but how much he may trust to a particular specimen of it; and therefore he wants to know what is the *least* weight that broke a fair, uniform, sound beam under given circumstances.

The first set of constants will guide him in the choice of his material, but if he begins to calculate the dimensions from the formula, as in Turnbull, he wants a different constant, viz: the one I have above pointed out.

My attention was drawn to this subject by reading the following passage in Professor Barlow's book on Strength of Materials, page 26.

"*Practical Rule.*—Since the strength of direct cohesion must necessarily be proportional to the number of fibres, or to the area of the section, it follows, that the strength of any iron rod will be found by multiplying the number of square inches in its section by the corresponding tabular number as given above.

"This, however, gives the absolute strength, or rather the weight that would destroy the bar; and practical men assert that not more than one-fourth of this ought to be employed. I have, however, left

more than three-fourths of the whole weight hanging for twenty-four or forty-eight hours without perceiving the least change in the state of the fibres, or any diminution of their ultimate strength."

It will be seen that Professor Barlow uses the expression "absolute strength" in the way in which I have proposed to use "relative strength."

I say that if he proposed the smallest weight instead of the mean, the result would be one which practical men ought to trust. As to the arbitrary "one fourth," it only shows that we have not yet succeeded in proving to practical men that we can do them any good, and Mr. Barlow justly intimates that there is a great sacrifice of the powers of the material in this very arbitrary reduction.

I trust to offer some further remarks on this interesting subject,—as well as to be able to lay before your readers at a future time results of experimental enquiries made by Mr. Ranger, our lecturer and professor of general construction. I hope we shall be able to point out some very important features in the case, to which as yet but little attention seems to have been given.

College, Putney, July, 1845. M. Cowie, *Principal.*

Civ. Eng. & Arch. Jour.

Comparison of English, French, and Belgian Railways. The Fares charged, the Expenses and the Profits.

While so many railways are in the course of construction, it is interesting to know as exactly as possible every item of expenditure connected with them. An able engineer, M. Julien, under whose direction are the works on the line from Paris to Lyons, has undertaken to give an idea of these expenses. The reports of the railways of France and abroad supply him with materials which he has admirably digested and arranged.

Average Cost of Railway per mile.—The first thing that strikes us in M. Julien's Memoire is the observation that the average of 300,000 fr. per kilometre (£19,200 per mile,) generally admitted as the probable cost of construction of the main line in France, *is certainly too small.* Of this M. Julien has given proofs. This is an important consideration at a time like the present, when speculation is so eagerly directed towards railways. On many of the English lines the expense has been from 700,000 to 800,000 fr. (£44,800 to £50,200 per mile. In France we cannot expect the cost to be less than 350,000 to 400,000 fr. on the average (£22,400 to £25,600 per mile.)

Comparison of Fares charged in England, Belgium, and France.—On the first view, one would imagine the difference between one railway and another to be so great that it would be in vain to attempt to reconcile them and deduce general laws. The fares, the number of passengers, their distribution among the classes of carriages, would seem liable to infinite variation according to the frequency of trains, the gradients, the curves, and every thing else which has an influence on the expense and profits. M. Julien has, however, in the general

results, collected some very singular coincidences. What can be more dissimilar than the rate of fares in England, France, and Belgium? The fare per mile actually received appears on the average—

	First Class.	Second Class.	Third Class.
*In England,	2.88 d.	1.824 d.	1.2 d.
†In Belgium,	1.20	.88	.56
In France,	1.60	1.20	.80

Then, again, the manner in which the passengers are distributed into the three classes differs very considerably. Of 100 passengers the average proportion in each kind of carriages will be—

In England	18	passengers	in the first class,	46	in the second,	36	in the third.
In France	15	"	"	30	"	55	"
In Belgium	10	"	"	27	"	63	"

The total return per mile is in England £2,236, in Belgium £1,160. It is nevertheless a curious fact that the traffic is apparently the same in Belgium as in England, and it is the traffic which affords the criterion of public utility. The Birmingham railway now produces £7,208 per mile; the Orleans line returns are stated at less than £3,200 per mile; M. Bartholomy in a recent work has stated the amount at £2,816; but the Orleans railway will have numerous extensions, and will probably produce one half the return of the Birmingham, with a rate of fare half less, and on the supposition of an equal traffic.

M. Julien has also pointed out another resemblance. The English lines, on the average, derive two-thirds of their revenues from passengers and one-third from luggage, and the proportion is found to be as nearly as possible the same in Belgium.

Comparison of the Actual Cost of Conveyance in the Three Countries.—What is most singular is that, on the railways of all countries, the total amount of general expenses corresponding to the running of a train over one kilometre of ground is as nearly as possible 3 fr. (about 3*s.* 10*d.* per mile,) and this expense is divided into two equal parts, of which one represents the force of locomotion and the wear of material, the other the expense of management by clerks and superintendents and the general working of the railway.

* It is singular to observe in the above table that the fare of a third class passenger in England is that of a second class passenger in France and of a first class passenger in Belgium. In the above calculation we have reckoned the centime = 1-10 of a penny, but its real value is at present rather less.—Ed.

† We were much struck with the low charges of railway traveling in Belgium, as compared with those of England. From Antwerp to Brussels, for example, a distance of 24 miles, the fares are,—diligences, 3 francs 50 cents; chars-a-bancs, 2 francs 25 cents; and wagons, 1 franc 75 cents; that is 2s. 9½d., 1s. 7½d., and 1s. 4¾d.; whereas the same distance upon any of the great lines in England would be above 6s., 4s, and 2s. Upon an average we found it to be only about one-half the expense of similar traveling at home. The consequence is that far more people travel by railway in Belgium than in England. We were astonished at the crowds that went with us in every direction, but more particularly between Brussels and Antwerp, and towards Ghent and Bruges. The increase in the receipts of the different lines has been great, as the advantages have been developed. The lines now in operation were completed in October, 1843; since which time their receipts have increased in an extraordinary proportion. During the past year (1844) the traffic of heavy merchandize was nearly double the amount of the preceding year, amounting to about 500,000 tons. The increase of passengers was still more extraordinary, that traffic alone having realized something not far short, it is said, of 10,000,000 francs.—Ramsay's Belgium and the Rhine.

To express by a clear formula the expense of working a railway, M. Julien has drawn a relation between the goods carried and the passengers who form the principal item of the receipts. The basis of this relation is perfectly plausible. He has accordingly expressed the whole amount of traffic, both for goods and passengers, by a certain number of passengers. His unit of calculation is *one passenger carried one mile*, and all he has to find is the cost of this unit including every expense. He has found that it is—

	Per kilometre.	Per mile.
On the Belgian lines,	2.7 cents	or .432 of a penny.
On the Orleans in 1844,	2.9 "	.464 "
On the Gard in 1842,	2.7 "	.432 "
" 1843,	2.5 "	.400 "
On the St. Etienne and Lyon in 1843 when the difficulties were peculiarly great, . .	3.5 "	.560 "
On the Strasburg and Basle, the traffic being small, . .	4.5 "	.720 "
On the English lines, exactly,	4.8 "	.738 "

The last amount however includes the English Government tax, and is accounted for by the smaller number of passengers in each train, for the English companies, correctly or erroneously, prefer a few passengers paying well to a great number paying little: they also have very frequent trains, persuaded justly that what most concerns them is not to spend comparatively little but to obtain a large gross return. If the passengers of an average train were the same in number in England as in France, and if the government tax were equal also, the cost of each passenger per mile would be the same as with us.

Merchandize.—According to M. Julien's comparison a ton of merchandize carried by slow trains costs rather more than 5 centimes in France and Belgium, (.8 of a penny per mile,) and in England 7 centimes (1.12 *d.* per mile.)

Proportion of Expenses to Profits in the three countries.—With us the Government often, and the committees of the chamber of Deputies always, have admitted as an absolute rule, that on a railway the expense represents 45 per cent. of the returns whatever their amount, from which it is concluded that the net profit is 55 per cent. of the receipts. This opinion has had the unfortunate effect of greatly exaggerating the net profit of poor railways. M. Julien has not had much trouble in proving the inaccuracy of this opinion, all accredited as it is. The more railways are frequented, or, the traffic remaining the same, the more the fares are raised, the greater proportion will the profit bear to the total returns. For there are a large number of constant expenses which have to be incurred *in every case*. On the English railways, which in 1842 gave altogether a receipt of 111 millions of francs, or (£4,625,000,) and an expenditure 48 millions of francs, or (£2,000,000,) the expense was not more than 43 per cent. of the total receipts; consequently the net profit was 57 per cent.: and it would have been as much as 62 per cent. if the English Government tax were as moderate as our own. On the Belgian lines

however the expenses are 60 per cent. instead of 43, and on the Strasburgh and Basle 73 per cent.

In the expenses as stated above, the interest of capital is not included; all that is reckoned is the actual cost of working the lines; otherwise we should have to add in France to the expense a sum of 17,500 fr., or 20,000 fr. per kilometre (£1,120 to £1,280 per mile,) representing an interest of 5 per cent. on the cost of constructing a railway with a double line of rails. And since we can scarcely expect in France an average total return much larger than that of the Belgian lines, which is about 20,000 fr. per kilometre, this item alone swallows up the total receipt.

Reserve Fund for renewal of rails.—In the accounts of railways an item ought to be presented which has not hitherto been introduced into them, because the railways are at present new, but which will soon have to find a place: and that is—an annual reserve to collect the capital necessary for a future renewal of rails. How long will the rails last? Twenty years, perhaps, and the crossings and sidings ten or twelve. A double line costs about 80,060 fr. per kilometre (£5,120 per mile.) To form this capital M. Julien proposes to reserve annually 4,000 fr. per kilometre of the line (£256 per mile.) M. Julien is right, and the commissioners have made a great mistake in omitting this consideration in their calculations. The capitalists, if they be wise, and seek, not adventurous speculations, but sound investments, will not commit the same error. On the whole the perusal of M. Julien's Memoir is of the nature to abate any very exalted notions on the subject of railways, and will give valuable information to those about to embark their fortune in those enterprizes.

Jour. Des Debats.—Ibid.

Prevention of Incrustation in Boilers—Dr. Ritterbandt's process—Mr. Johnston's Patent Boilers.

Sir,—From your remarking on Dr. Ritterbandt's patent, "this has every appearance of being an eminently useful invention, we have never before seen the great evil which it is intended to obviate, grappled within so scientific and effectual a manner," you are evidently predisposed in favour of his invention; yet, from the impartiality you have displayed towards all controversial writings which I have perused in your Magazine for a series of years, I am satisfied that you will find room for the insertion of the following remarks on boiler incrustations.

Scientific men have long labored under the delusion that the deposits in boilers are insoluble, owing to their being chiefly composed of sulphate of lime.

I am much gratified to find that Dr. Ritterbandt and others are now convinced that it is "*the heat employed to generate steam* causing the lime which exists in the water, in the form of *soluble bicarbonate of lime*, to be converted into an *insoluble carbonate of lime;* and (that) in marine boilers, incrustation is generally promoted by the carbonate of lime set free *by the heat*, which, as it floats in the water

previous to subsidence, forms nuclei for the accrescence of other matter, and disposes the saline compounds, such as the sulphate of magnesia, chloride of sodium, *to chrystallize and precipitate much sooner than they otherwise would.*"

These are Dr. Ritterbandt's own words, and he is perfectly right in the opinion conveyed by them, viz, that it is heat which causes the salts, both in marine and land boilers to pass from the soluble to the insoluble state.

The Doctor admits or rather declares, that the heat is the grand cause of the disease; and, in order to alleviate it, he puts into the boiler a quantity of ammoniacal salt. Now in this treatment of the patient I do not agree. Instead of attempting to alleviate, I have succeeded in removing the cause—*the heat.*

The temperature to which water is raised in the act of being converted into steam in a boiler is not sufficient to cause the salts to pass from the soluble to the insoluble state. This change is produced by the *over*-heated state of the metal of the common kinds of boilers; an over-heating which is not at all a necessary accompaniment of the converting of water into steam by the application of fire to a boiler.

The existence of minute globules of steam on the metal of boilers is the cause of its becoming over-heated. By constructing boilers so that currents of water are formed in them, which sweep along the heating surface, and remove from it the globules of steam the instant they are formed, the metal of the boilers never becomes hotter than the water it confines; and consequently, the salts in a boiler thus constructed can nowhere receive that amount of heat which is necessary to make them pass from the soluble to the insoluble state.

I have had a seven-horse power boiler constructed according to this plan, working for the last thirteen months; a portion of that time it was worked with sea-water, and the remaining time with fresh water, which naturally contains a quantity of lime; yet no deposit has ever formed within the boiler.

The fact, that the red-lead paint with which the interior of the furnace and flues were painted thirteen months ago, is still in good condition, is a most convincing proof that the metal never exceeds in temperature the water which it confines.

The subjoined accounts of some experiments on this subject would I think, be new and interesting to some of your readers, if you can find room for them.

Willow Park, Greenock, JAMES JOHNSON.
July 3, 1845.

Experiment First.—Put fifty cubic inches of sea water into a vessel, and place it in a water bath over a fire; the temperature of the vessel containing the sea water can never exceed 212° Fahr., as the intervening water of the bath prevents it. After the bulk of the water has been diminished by evaporation until there is only ten cubic inches of water remaining, then allow it to cool, and it will be found that no crystals or hard deposit of any kind has been formed: a considerable quantity of a soft flocculent substance will have settled to the bottom of the vessel; but the slightest motion of the vessel

causes it to move about, and on again applying heat to the vessel the flocculent matter rises up and is dispersed throughout the water. Let the evaporation now be carried on until there be between seven and eight cubic inches of water remaining, and then allow it to cool; it will now be evident, by the existence of a few small crystals, that the water is a saturated solution.

This experiment proves that no hard or injurious deposit will be formed in a vessel in which sea water is evaporated, until the water has become a saturated solution, provided the vessel containing the water be not heated beyond 212° Fahr.

Experiment Second.—Place other fifty cubic inches of the same sea water in a Florence flask over a gas light for evaporation; after the water has become thoroughly heated it will assume a milky white appearance, and immediately after the flocculent matter will become visible throughout the water, the same as in the first experiment.—Continue the boiling of the water until there is about nineteen cubic inches remaining; if the bottom of the flask be now carefully watched, small specks of a hard scaly deposit will be observed forming; count their number, observe their size, and allow the flask with the water to cool; when cold it will be evident that no increase has taken place in the quantity of the hard deposit, but the soft flocculent matter will have settled down on the bottom of the flask. The specific gravity of the water will now be 1070, and it will float one of Twaddell's hydrometers to the 14°. Apply the flame of the gas again to the bottom of the flask; all the flocculent matter will immediately rise up from the bottom and be dispersed throughout the water, without any increase being made to the scaly deposit previous to the water having commenced to boil; but as soon as ebullition has fairly commenced, then the scaly deposit will begin to increase and go on as it did at first.

Now this experiment shows that scaly deposit is only formed during the time the water is boiling, and where the ebullition is greatest.

There is another fact connected with this experiment which I must make known, If the hard deposit was formed in consequence of the water being saturated with matter, it is reasonable to suppose that the deposit would fall to the bottom in a circular or round shape, as the bottom of the flask is spherical, but this is not the shape that it assumes. The gas flame which I used was what is called a swallow-tailed burner; the top surface of the flame next the flask is a flat narrow strip, and, what is very remarkable, this hard deposit inside the flask is formed in the shape of a narrow strip crossing the bottom of it, and exactly coinciding with the flame outside. From this it is evident that the hard scale is formed in consequence of the overheating of the part of the flask acted on by the flame.

* * * * * * *

When the salt water comes in contact with the over-heated plates, they produce or cause a premature crystallization. The process is a production of salt from water which is not saturated.

Can any other circumstance connected with the working of boilers

but the over-heating of the plates be assigned as the reason why the water in marine boilers deposits salt, although it is not a saturated solution?

After a little reflection on these observations, the following question is likely to be suggested, and I shall therefore answer it.

As the salt is produced from water that is not saturated, by the over-heating of the plates; why does the salt not re-dissolve after the producing cause has been removed, by the boiler being allowed to to cool?

Now the fact is, that salt thus produced does re-dissolve into the water from which it was taken, provided another change be not allowed to take place; for after that change it is insoluble even in fresh water.

I frequently repeated the second experiment, and in all my trials of it but one, I found that the scale of salt formed, gradually dissolved in the course of twelve hours after the boiling ceased. The trial in which the scale did not re-dissolve at first excited my curiosity, but I soon found out the cause. The person that I sent for the sea-water on this occasion brought it in a rusty iron vessel, and the water had absorbed a considerable quantity of the oxide of iron from it. When the water was boiled, the oxide of iron united with the scale, and formed an insoluble compound. In the other trials pure sea-water was used, and it could receive no oxide of iron from the vessel in which it was boiled, as it was a glass flask; therefore in those repetitions of the experiment the scale dissolved when the water cooled.

Marine boilers are themselves the source whence the scale receives the metallic oxide, and becomes an insoluble compound.

In making the above experiments, I observed that the coating of deposit, after being formed, did not continue to increase in thickness so rapidly as I supposed it would, judging by the rapid manner in which the first coating was formed, and the reason why it did not do so, is owing to the first coating being attached to a firm substance (the glass;) whereas the succeeding coatings required to attach themselves to the first coating, a substance which was, comparatively speaking, soft, and from which it was easy for the bursting bubble of steam to detach portions of the newly-formed scale.

On carrying on the experiments for a length of time, I found that there was a considerable quantity of those detached portions of scale moving about in the water. Now I think it will be admitted, that the same circumstances will occur in marine boilers: viz. that when scale has been and is continuing to be formed in a marine boiler, there will always be suspended in the water minute portions of detached newly-formed scale, and as you are aware that this scale has an affinity for iron, the only conclusion that can be drawn is, that those portions of scale are carried by the ebullition of the water to the comparatively speaking quiescent side parts of the boiler, where they have undisturbed freedom to satiate themselves with their favorite, the iron composing the shell, with which they soon become united in the form of a hard crust.

From a careful inspection of the two kinds of scale, it is evident

that scale from the flues of a marine boiler is of a hard crystalline nature, whereas that from the shell is of a soft, chalky structure,—facts which corroborate my experiments and theory.

I now consider it an established fact, that the premature crystallization in marine boilers, from water which is not saturated with salt, is caused by the local action of the over-heated plates on the water which comes in contact with the plates immediately after each bubble of steam has detached itself from the plates. Mechanics' Mag.

Embankment across the Valley of the Brent.

Mr. Colthurst exhibited and described,* three sections of the embankment across the valley of the Brent, at Hanwell, on the line of the Great Western Railway.

The embankment, which was formed of gravel, was 54 feet in height; it rested on vegetable soil, beneath which was a thickness of 4 feet of alluvial clay; then occurred a bed of gravel, varying from 3 feet to 10 feet in thickness, resting upon the London clay which was traversed in all directions by slimy beds or joints.

The surface of the country sloped gradually towards the Brent, which was at a level of about 20 feet below the south side of the embankment.

The subsidence of the embankment commenced during the night of the 21st of May, 1837; the next morning, the foundation was discovered to have given way, and a mass of earth, 50 feet in length by 15 in width, was forced from beneath the north or lower side of the embankment, towards the Brent. For four months this protruded mass increased in dimensions, and the subsidence of the embankment continued, until the surface assumed an undulating outline, which, on being cut through, showed that the subjacent beds corresponded accurately with the curvatures produced at the surface by the disturbance. The state of the seams or strata beneath the surface, was ascertained by sinking trenches at right angles to the embankment.

The symptoms of failure in the embankment, at this period, were confined to a subsidence of about 15 feet, with a fissure extending all along the top of the south slope, at the side opposite to where the foundation had yielded. From the dip of that fissure, Mr. Colthurst inferred the nature and inclination of a rupture of the ground under the embankment.

Immediately on the commencement of the slip, Mr. Brunel directed a terrace to be formed, on the swollen surface, at the north foot of the embankment; the weight of the mass thus placed, succeeded effectually, in stopping the further progress of the subsidence, which up to that period, had exceeded 30 feet. The swollen ground extended over nearly 400 feet in length, by about 80 feet in width, and was elevated nearly 10 feet, with a horizontal movement of about 15 feet. The general disturbance, ranged to a distance of 220 feet from the foot of the slope, towards the river Brent, the south bank of which, was forced forward about 5 feet.

* At a meeting of the Institution of Civil Engineers, London.

The rupture of the ground beneath the embankment, was indicated by the crack near the upper part of the south slope.

In a letter received recently from Mr. Bertram, one of the engineers on the Great Western Railway, it was stated, that the Brent embankment had subsided very little for several years; indeed, from the nature of the material, there was naturally less sinking, than in loosely formed clay embankments; a coating of ballast from 6 inches to 9 inches in thickness, applied once a year, was found sufficient for all purposes.

The slips which occurred in embankments formed of clay, occasioned trouble at first, by their immediate effect on the road above, and the difficulty of adding material to them. Mr. Bertram had found in many such instances, in the London clay district, that a temporary measure, of forming the softened mass which had slipped down, into large raised beds or ridges from 8 feet to 12 feet wide, by dressing with the spade, surface punning, &c., had the effect of keeping rain-water out, allowing the raised parts to dry, and retaining the mass in its place, until better weather and matured arrangements, permitted the more permanent proceeding of forming an extended footing and working up the mass with additional material, so as to fill up the space with an increased slope.

When the Acton cutting slipped about 3 years since, Mr. Bertram was induced (from the difficulty of bringing gravel to the spot, and the quantity of surplus stuff in the cutting,) to try burnt clay for the drains, for forming an open backing to collect water, and also for mixing with the soft clay in punning up again; from what he then saw, he gave a decided preference to that material, over any kind of gravel, for mixing with clay, to retain it in its place. When gravel was used, there was generally a slight subsidence and opening at the top, but with burnt clay neither occurred. The usual system pursued, was to form with that mixed material, continuous abutments and revetments, upon the original face, and in all cases to make sure of thorough drainage from the back.

He had always been able to trace an immediate connexion between courses of the septaria and the slips at Acton. Those courses were not sufficiently open to act as natural drains: he had made many surface and deep drains leading from them, but the quantity of water drawn off, was not equal to that which was obtained by the means before described.

At Ruscombe, he had removed the gravel stratum from the top, laying bare and well draining the surface of the clay, using the gravel as a footing or buttress below, at such portions of the cutting as had been forced up by previous slips; when there was under drainage from longitudinal culverts, that plan answered very well.

At that portion of the Sonning cutting, which slipped so suddenly two years ago, the stratum of gravel was found to be broken into, by an upraised bank or dam of clay, which, after much wet weather, kept a reservoir of water penned back, until it broke out the mass of clay, down to the next stratum: the dam had been cut across at different points in the slope for the purpose of drainage, and when that

was done, all that portion of the cutting became particularly dry. A drain was led from the back of the dam in dressing off the slip. That continued to bring away a great deal of water, which previously had some other outlet, over the lowest point of the bank.

Mr. Sibley thought, the causes of the subsidence of the Hanwell embankment were very obvious. In laying out the foundation of the Lunatic Asylum, in that immediate vicinity, and in the formation of a deep sewer, with a soil pit 20 feet in diameter, and 20 feet in depth, at the side of the Brent, he had ample opportunity for examining the strata, and it appeared to him, that had a trench been made in the direction of, and at the foot of the embankment, the marshy piece of land where it was situated, would have been sufficiently drained, to enable it to carry the weight of the mass laid upon it.

The trustees of the Uxbridge Road had their great store of gravel, in fields to the west of this embankment, and excavations had been going on there for about half a century. The springs in that neighbourhood, accumulated in a reservoir which was formed by an escarpment of clay, skirting the river Brent; part of the waste water, together with the percolation from the reservoir, was permitted to traverse the site of the embankment, rendering the ground marshy even in the driest seasons.

The late Mr. M'Intosh had frequently told him, that a larger quantity of material was used in maintaining, than in constructing, the Hanwell embankment.

In answer to questions from members, Mr. Colthurst explained, that the fissures shown in the clay, beneath the embankment, were assumed from the form of the depressions of the surface. The sections of the ground were taken weekly, during the whole time of the subsidence, so that he contended, the form of the substratum might be assumed as being correct.

The spreading of the lower side of the embankment, displaced the bank of the river Brent for some distance.

Sir Henry Delabéche remarked, that if the sections which were exhibited, approximated to truth, it would appear, that the embankment was formed upon a fault of greater magnitude than usual. The consequences were inevitable; when the fault yielded, the embankment sunk, and continued to subside, until the mass was stopped by weighing the foot, and thus restoring the equilibrium.

Mr. Colthurst said, that the slimy beds, and the fissures. which ran in all directions in the clay, were most difficult to be guarded against, and they were, he believed, the principal causes of slips and subsidences.

Mr. Braithwaite said, that from the observations of Sir Henry Delabéche, it might be be inferred, that slips and other movements of earth, were more frequently due to mechanical, that to chemical action, although in the case of the New Cross slip, the latter had been much insisted upon.

Mr. John Braithwaite gladly availed himself of the geological knowledge of Sir Henry Delabéche, and his approbation of the measures pursued was highly gratifying to him.

With respect to the Brentwood cutting, although the strata were nearly horizontal, and it might have been imagined, that there would be little tendency to slip, yet from the ground being so full of water, more than ordinary attention to its drainage was required, for it was so retentive of moisture, that a drain had but little influence at a few yards from it.

The draining shafts which were sunk, had operated well, to the extent to which they were carried, and he believed that generally, the mode of treating the Brentwood cutting was considered successful.

He had understood, that the trenches which had been alluded to, had not been extensively used.

Mr. Phipps explained, that the trenches and the wall with dry backing, were tried under his direction merely as an experiment, prior to the examination of the ground by Sir Henry Delabéche. The dry shafts were subsequently sunk, and the only doubt he entertained was, whether there was a sufficient number of them to drain the bank effectually.

Sir Henry Delabéche said, there could not be any doubt of the ground being completely drained, if a sufficient number of shafts were sunk to intercept the water, but then the question of their cost must be considered.

In answer to questions from the President, Mr. Green stated, that his experience did not enable him to lay down any rule for the prevention of slips in cuttings or embankments. They were generally to be attributed to the presence and pressure of water, acting upon the substratum; the method of discharging the water must depend on the direction and nature of the strata; in all ordinary cases, he conceived, that with proper application of the known methods of drainage, successful results might be attained.

He had not made any particular observations, as to the relative duration of the tendency to slip, exhibited by the slopes of embankments and cuttings, in canals and railways; but he conceived, that in a canal, the weight of the water acted as a support to the internal slopes, and tended also to counteract the upward pressure of water in the substrata. He had frequently observed this in cuttings, with embankments on the sides; while the canal was full of water, the banks stood well, but when the water was drawn off, the banks subsided, and the bottom of the canal rose up.

A curious instance occurred in forming part of the Exeter ship canal, through mud lands in the estuary of the Exe. The embankments on the sides of the cutting remained firm, so long as their weight only just balanced the upward tendency of the water in the substratum of the bed of the canal; but when the increased weight of the mass destroyed the equilibrium, the embankments sunk down, and the bottom of the canal was forced up in proportion.

This occurred in several places, even after the works had preserved a perfect section for some months; but the canal had not then been filled with water. It was found, on examination, that at a few feet only below the bottom of the canal, there existed a bed of peat, which, although capable of resisting the weight of the banks for a considera-

ble time, at length gave way; thus the embankments sunk down, the bottom of the canal rose up, and it became necessary to drive strong piles in the line of the bottom of the canal, on each side in a lateral direction, and to support these piles by rough inverted arches of stone, at intervals of about 20 feet, for a considerable distance; after which, the banks, being slowly raised, stood well.

The President said, it must have been observed by all engineers that in the embankments and cuttings of canals, the slips generally occurred within the first six or eight months after the works were completed; but in railway works, the slips constantly occurred even after years had elapsed. He observed on many of the railways on which he habitually traveled, that the slopes were almost as frequently under repair, after being open for many years, as they were within a few months of the first opening. He was decidedly of opinion, that, although water might be the primary cause of the slips, the vibration caused by the passage of the trains, was the more immediate cause.

When, as had been so ably explained, the lower beds became converted into mud, and the adhesion of the particles was destroyed, the mass only required a slight impulsive force, such as the vibration consequent on the passage of an unusually fast or a very heavy train, to set it all in motion and to cause a slip.

Some of the methods proposed for the formation of embankments, such as only constructing them during suitable weather, and with thin layers of material regularly laid and pounded, &c., might be used in the construction of reservoirs for containing water; but they were not compatible with the manner in which extensive works required to be carried on, independent of the extra cost they would occasion. Experience had shewn him that the best method of constructing a heavy embankment, was, to run forward two tips, parallel with each other, forming the outsides of the bank, and leaving a void in the centre which was subsequently filled up. The greatest amount of pressure was thus brought to act vertically upon the material, and the two sides having become somewhat consolidated, were better able to resist the pressure, and they had not any tendency to slip away.—This method had been ably treated by Mr. J. B. Hartley, in a paper read before the Institution some years since.

He had not found any difficulty in inducing contractors to adopt that method; when proper precautions were taken to insure thorough drainage, he believed that embankments would, generally, stand well, although made in the wettest weather. Moisture would only cause the mass to become more consolidated; and, when that was once the case, but little water would subsequently percolate.

He concurred in the opinion, that the gravel counterforts acted rather as drains, than as supporting buttresses; for he believed, that they stood, generally, at a steeper angle than the slopes which they were supposed to support.

Mr. Clutterbuck said, in confirmation of the President's opinion, he had been told by the persons who worked in the sand-pits, under the plastic clay, near the London and Birmingham Railway, that they

were afraid to remain underground during the passage of the heavy luggage trains, on account of the extreme vibration of the earth.

Mr. Green was convinced of the correctness of the President's opinion, as to the effect of vibration upon banks saturated with water. He had seen instances, even in canal embankments, where, at the head of locks, the vibration arising from the sudden and careless closing of the lock-gates had produced slips.

He did not think any commensurate benefit would result from the extra expense of pounding the earth in embankments, as had been suggested. The degree to which earth might be safely consolidated, by pounding, could only be determined by great attention to the nature of the material, and to the circumstances under which it was used. He had known much injury caused by the earth backing for walls, being too much pounded, when, from defective drainage, the expansion of the earth had, subsequently thrown the walls down.

Mr. Hughes presented a specimen of Watson's drain pipes. They were made of Staffordshire clay, which possessed great strength and durability; and they had also been made of cast iron. The apertures in the periphery were enlarged, inwards, so as to prevent the possibility of their choking up. The holes were so small that but little earth could be carried in with the water; but, if any did enter, it fell through into the body of the pipe, and was washed out by the water. The drain tile also having the same kind of apertures.

These pipes had been successfully used, for some time, in the cuttings of the London and Birmingham, and the Croydon railways; and Mr. Hughes promised to give, during the next session, a report of the method of using them, and of the result of their application in several wet cuttings. Jour. Arts & Sci.

First Annual Report of the Directors of the South Carolina Railroad Company, for the year ending December 31st, 1844.

Continued from page 164.

Extract from the Report of the Committee of Seven, to which was referred the Annual Report of the Directors of the South Carolina Rail-Road Company, and the accompanying documents.

The next matter to which your committee will direct your attention, is that portion of the report, which refers to the construction of a Rail-Road to Camden; and also, to the resolutions from your Board of Directors on the same subject, which recommend that you accept the Act of the last session of the Legislature, for the construction of a Branch to Camden. Your committee, being deeply impressed with the importance of this work, to all concerned, that is the Stockholders, the City of Charleston, the Town of Camden, and all that large portion of country that will be enabled to avail itself of the advantages of the Road, and all those whose business connexions are, or may be, with Camden, by which they will be furnished with a better market, both to sell and buy in, recommend that you adopt the resolutions of the Board. As this is a grave question, and one involving the expenditure of a large amount of money, we presume, it will be expect-

ed of us that we should furnish the data, upon which we have come to the conclusion, that it is the interest of all the parties above-named, that this work should be undertaken. We will proceed now to do so, and as you are assembled to look after your own business, and as your interest should be the prompting motive to accept the Act of the Legislature, we will in the first place endeavor to prove, that it is the interest of this company to do so. And with that object, we will submit an estimate of the probable income and expenditure, assuming that the Road will cost $500,000, which in the present state of our information, is as probable as any other sum. One of the estimates of the Engineer, being below that amount, and the other, for near a corresponding amount above it;* and the highest of the estimates referred to, would be reduced within this sum, provided the Federal Government should reduce the duty on iron, before the time at which it is required. The estimate of income and expenditures is

Transportation of 50,000 bales of cotton, at 75 cents per bale, - -		$37,500 00
Up freights equal to those down, -		37,500 00
12 passengers up and down daily, at $6, -		52,560 00
For carrying the small mail, - -		4,000 00
Gross Income, - -		$131,560 00
Items of Expenditure.		
Interest at 7 per cent. on cost of road, estimated at $500,000,	$35,000 00	
Repairs of 40 miles of road, at $300 per mile, per annum,	12,000 00	
Expenses of work-shops including workmen, and all materials on 204 miles, is $60,000, on 40 miles at the same rate, is -	11.220 00	
Daily expenses of one passenger's car, to the main Item, is $8.50; per an.,	3,102 00	
Expenses of a train of freight cars from Camden to Charleston, per trip of 3 days, $29.25; per annum is, allowing for 100 trips per annum,	2.925 00	64,247 00
Nett profits of Branch, is - -		$67,313 00
This would be within a small fraction of $2\frac{2}{3}$ per cent., on all the present stock of $2,604,000. But suppose the above estimate of passengers, to be too large, and we deduct one-half, say, leaving only 6 daily, -		26.280 00
Nett profit is, - -		$41,033 00

Or $1\frac{2}{3}$ per cent. on all the stock, say $2,604,000.

* The amounts depending on the kind of iron rail which may be adopted.

If the above estimates of the income of the road be correct, there can be no doubt of the propriety of construction, and these your committee will now consider somewhat in detail. First, of the 50,000 bales of cotton. As to this item, it is within the personal knowledge of some members of your committee, that the amount of cotton to be brought within the reach and influence of this road is nearer 70 than 50 thousand bales; in fact, Camden and Wright's Bluff, alone, would furnish the quantity, without taking in some 20,000 bales that are shipped at intermediate points, or wagoned to this market; and also, without making any allowance for the large accession of cotton, which would be brought to Camden, and which is now sold in Cheraw, and is thence shipped in part to Charleston, but principally to New York by the way of Georgetown. As there is no doubt of this being the quantity of cotton, the question arises, will the Rail-Road obtain the transportation of it? of this, there cannot be a question, at the rate of freight assumed by your committee, that is 75 cents per bale. The present rate of freight from Camden to Charleston, is $1 per bale, which is the lowest it has ever been for any season, and is as low as it can be brought by boat. No boatman can long continue to bring cotton, from Camden to Charleston, at 75 cents per bale. But in competition with the Rail-Road, he could not get even this, as the Rail-Road insures the delivery of cotton upon it; and to procure such insurance, either the boatman or the owner of the cotton, would have to pay 10 cents per bale for insurance: which would require the boat owner to carry at 65 cents per bale. Besides, the road would even at this rate have the preference, as it would deliver the cotton with greater certainty, and at a saving of time.

As to the second item of income, experience leaves us no room to doubt, that the up freights will always exceed those down. The Committee have had before them, the Reports of the Road from 1834 to 1845 inclusive, being eleven years, and embracing in those eleven years, every variety of seasons, and periods of the greatest commercial and agricultural prosperity and depression; so that, all reasonable tests have been applied, by which we can judge such a question; the result is well worth consideration. A table is appended to this report, headed "Freight Statement," which shows the operations of each of these 11 years, and from it, we find, that in that period

The up freights have yielded an income of	$1,208,336.19
The Down freights " " -	786,679.04
Showing, excess of up freights over down freights of	$421,657.15

Averaging during these eleven years, an excess of income from up freights over down freights, annually, of - $38,332.47
being very nearly 57 per cent.

It is not, however expected, that this disproportion will continue; it has in fact diminished in the last two years and a half, not from diminished up freights, but from increased down freights, the road having brought greatly increased quantities of cotton and other heavy articles down, during that time. The wise policy of the Directors, in

lowering and affording every facility for bringing down the cotton and other produce, while it has increased the income greatly from down freights, has added considerably, but not in the same ratio, to the up freights. The same results, perhaps more favorable ones, may be expected from this Branch—the *very least* that can be counted on, is an equal amount, which the Committee has assumed.

FREIGHT STATEMENT.

From 1st Jan. to 30th June.			*From 1st July to 31st Dec.*		
	AMT. UP.	AMT. DOWN.		AMT. UP.	AMT. DOWN.
1834	$19,553 31	$9,701 49	1834	$37,054 15	$18,503 49
1835	35,553 15	12,630 50	1835	53,683 90	29,915 39
1836	51,906 00	19,288 13	1836	49,428 96	19,410 75
1837	35,038 02	10,543 24	1837	49,919 65	42,768 26
1838	51,558 24	25,458 45	1838	58,438 48	26,936 55
1839	52,203 39	17,306 45	1839	70,573 02	57,240 64
1840	61,198 18	57,193 89	1840	49,534 28	20,577 19
1841	46,730 98	28,610 09	1841	59,219 66	27,425 20
1842	67,248 36	23,134 28	1842	64,741 05	72,741 33
1843	61,680 25	53,471 87	1843	67,656 42	65,052 88
1844	71,631 02	54,487 54	1844	85,755 72	94,281 43
	$562,330 90	$311,825 93		$646,005 29	$474,853 11

As to the third item of income, that is from passengers, your committee believe, that the larger estimate will be the one which will be found to be correct, as it will open to the road, all that portion of the state below Camden, and east of the Wateree river; and which is now measurably deprived of the facilities of the same, even though within a distance to reach it, as there is no bridge over that river from Camden down; nor is there a ferry, which at all times can be crossed, nearer than Vance's, which is 60 miles below Camden, and too far south, to offer an inducement to go to the road. The influence of this road, would also command considerable travel from Cheraw, or the Pee Dee section of country, and from North Carolina, which your committee believe would give the higher estimate of passengers, but unquestionably the lower, that is 6 passengers daily.

The item for the transportation of the Mail is the lowest rate that can occur.

As to the expenses of the road, the first item of $35,000 speaks for itself, being the interest on the estimated cost of the road, say $500,000; and as to the other items, they are all taken from the books of the company, and are of unquestionable authority.

Your committee for the foregoing reasons, have no hesitation in recommending to the company to accept the Act, so far as the interest of the company is concerned.

Statement of the number of Passengers conveyed upon the Railroad between Charleston, Hamburg and Columbia, with the amount received for Freight and Passage, from 1st January to 31st December, 1844.

	PASSAGE.						FREIGHT.			
	UP.		DOWN.		UP AND DOWN.		UP.	DOWN.	UP AND DOWN.	TOTAL AM'NT.
	No. Pass.	Amount Passengers.	No. Pass.	Amount Passengers.	No. Pass.	Amount Passengers.	Amount of Freight.	Amount of Freight.	Amount of Freight.	Freight and Passengers.
January	2,277	7,342 83	1,804	6,265 27	4,081	13,608 10	11,067 36	15,353 38	26,420 74	40,028 84
February	2,455	8,388 16	1,926	7,949 92	4,381	16,338 08	12,543 79	15,985 90	28,529 69	44,867 77
March	2,750	9,718 20	1,906	7,015 55	4,656	16,733 75	19,077 76	6,557 21	25,634 97	42,368 72
April	5,556	9,581 92	5,365	8,977 13	10,921	18,559 05	13,454 48	4,560 21	18,014 69	36 573 74
May	2,106	7,123 68	1,996	6,770 75	4,102	13,894 43	9,128 63	6,895 08	16,023 71	29,918 14
June	1,690	5,870 06	1,521	5,185 75	3,211	11,055 81	6,359 00	5,135 76	11,494 76	22,550 57
Total for first half year	16,834	48,024 85	14,518	42,164 37	31,352	90,189 22	71,631 02	54,487 54	126,118 56	216,307 78
July	1,663	5,412 22	1,442	5,073 60	3,105	10,485 82	5,986 52	3,931 62	9,918 14	20,403 96
August	1,584	4,980 11	1,502	5,104 73	3,086	10,084 84	7,355 69	5,424 42	12,780 11	22,864 95
September	1,674	6,792 48	1,326	4 534 78	3,000	11,327 26	20,521 56	9,213 02	29,734 58	41,061 84
October	2,532	10,317 70	1,843	6,848 31	4,375	17,166 01	26,001 92	27,283 12	53,285 04	70,451 05
November	2,267	9,101 27	1,779	7,157 14	4,046	16,258 41	15,985 97	24,719 56	40,705 53	56 963 94
December	2,810	8,443 42	2,372	7,563 10	5,182	16,006 52	9,904 06	23,709 69	33,613 75	49,620 27
Total for second half year	12,530	45 047 20	10,264	36,281 66	22,794	81,328 86	85,755 72	94,281 43	180,037 15	261,366 01

INCOME FOR FIRST HALF YEAR.

Income from Freight and Passage as above, first half year,	$ 216,307 78
" Mails, Rents, Storage, &c., . .	27,727 36
Total, . . .	$ 244,035 14

INCOME FOR SECOND HALF YEAR.

Received for Passengers and Freight, second half year,	$ 261,366 01
Tickets from Hamburg to Charleston, sold by the G. R. R. Co.	2,798 50
Carrying the Mails, ...	20,149 98
Freight not included above, ...	199 50
Transportation of Iron for the Geo. R. R. Co. . .	2,853 63
Rents, storage, oak wood sold, &c. . .	1,467 19
Total, ...	$ 288,834 81

Statement of the number of Bales of Cotton received in Charleston by the Railroad from 1st January to 31st December, 1844.

	Hamburg.	Aiken.	Blk'ville.	Midway.	Br'chville.	Way H. R.	Columbia.	Gadsden.	Louisville.	Orangeb'g.	Way C. B.	Total.
January	8,403	94	385	227	80	117	2,977	1,359	266	155	976	15,039
February	12,785	90	366	142	61	50	7,235	428	191	148	556	22,052
March	5,332	78	77	50	31	19	4,278	8	28	15	176	10,092
April	1,576	—	45	22	39	58	4,496	—	201	—	37	6,474
May	3,185	9	62	6	—	—	6,908	123	194	—	26	10,513
June	2789	—	12	2	—	—	3,174	57	—	1	—	6,035
Total, for first six months	34,070	271	947	449	211	244	29,068	1,975	880	319	1,771	70,205
July	1,913	—	8	—	—	1,767	8	—	—	—	107	3,803
August	3,111	—	34	34	42	1,463	147	31	—	—	128	4,990
September	4,892	28	156	239	187	5,022	234	472	—	194	295	11,719
October	13,595	120	436	248	181	13,954	1,406	727	205	296	1,273	32,441
November	11,827	196	720	317	143	14,947	770	388	364	278	1,132	31,082
December	15,972	82	504	271	66	12,341	1,214	318	236	216	1,178	32,398
Total for second six months	51,310	426	1,858	1,109	619	49,494	3,779	1,936	805	984	4,113	116,433

Statement of the number of packages and pieces received and forwarded upwards on the Railroad, in half year ending 31st December, 1844.

In July,	1,016	pieces and packages from	18 vessels.
August,	3,207	" "	16 "
September,	10,142	" "	28 "
October,	16 966	" "	49 "
November,	5 187	" "	38 "
December,	3,888	" "	24 "
Total,	40,407		173

Statement of articles received by the Railroad, and forwarded to other places in the half year ending 31st December, 1844.

4,784	bales of Cotton,	153	bags of Feathers.
280	" Yarn,	2	Wax.
2	" Merchandize unknown.	5	barrels "
39	boxes " "	2	casks "
6	barrels " "	6	boxes of Indigo.
1	bale of Wool.		
68	bales of Roots.		
50	bags "		

AMERICAN PATENTS.

List of American Patents which issued in the month of January, 1845, *with Remarks and Exemplifications. By* CHARLES M. KELLER, *late Examiner of Patents in the U. S. Patent Office.*

1. For an improvement in the *Press for Pressing Cotton;* William Bullock, Jersey City, New Jersey, January 4.

The patentee says—"The nature of my invention consists of an arrangement of a compound lever, in combination with an arrangement which is so contrived as to release the pressure after it has arrived at a certain limit, so as to have an uniformity in all the bales to be pressed."

Claim.—"What I claim as my invention and desire to secure by letters patent, is the combination of levers K, K, with the side links P, P, and with chains Q, Q, passing over rollers R, R, having vertical links to support the movable platen. I also claim the invention of the arrangement for connecting the self-adjusting platen to the machinery, by which the power is applied to the press, so that whenever it takes beyond a limited amount of power to propel the press, the simple action of the power in propelling the press will release the bale, until only the given amount of power is required. And I also claim the invention of the arrangement for connecting the above arrangement for adjusting the power upon the bale to the movable platen of the press, substantially in the manner and for the purpose set forth."

The main levers of the press, designated in the claim by the letters K, K, are jointed at each end to links P, P, attached to chains that pass over rollers, and are then connected with the lower (movable) platen by other links. The fulcra of these levers (they are not levers but four arms projecting from a shaft, two at each end) are in the middle of their length, so as to draw up both ends of the platen with equal velocity, and the lever that operates the whole press is their shaft. The rollers over which the chains Q, Q, pass have their bearings in horizontally sliding pieces attached to the frame above the bed of the press, and these are kept apart by a wedge-formed block on each side of the press, the upper ends of which bear on the periphery of an eccentric sector attached to the shaft of a segment cog wheel, the teeth of which take into the cogs of a pinion wheel on the arber of a friction or brake wheel, having a friction band passing around a portion of its periphery and connected with a spring. By this arrangement it will be apparent that when the power applied to the lever of the press is too great, the rollers Q, Q, will slide inwards, force up the wedge-formed blocks, and turn the friction brake instead of drawing up the platen, so that by increasing or decreasing the tension of the spring on the friction belt of the brake, the amount of force which the bale will receive can be regulated at pleasure.

2. For improvements in the *Printing Press;* John L. Kingsley, New York city, New York, January 4.

The patentee says—"In my improved press the inking apparatus, and that for making the impression, are in their general construction, similar to those employed in the most improved machines, but they are so modified and arranged as to adapt them to an entirely new apparatus for conveying the sheet to the required positions for printing them on both sides, or what is technically called perfecting the sheets; which is done before the sheets leave the gripper, by which they are deposited correctly in a pile ready for drying. By this arrangement, one person is required to feed the machine by supplying the sheets to be printed, the press being actuated by any adequate power.

In a machine thus arranged, one half the labor of feeding required in the best registering machine with which I am acquainted, namely, that of Tuft's, of Boston, is saved, and with the employment of two persons at the feeding board; his press affords only about six hundred impressions in an hour, whilst, as my machine takes two impressions to one sheet supplied, and the printed sheet is deposited without interfering with the feeder or feeding, it may be run at any speed which allows time merely for the inking and the supply of sheets, and may consequently make from twenty to twenty-five hundred impressions in an hour. My machine secures a perfect register, as the sheet which has been fed in the gripper does not leave them until it is perfected, when it is deposited as hereinafter described."

Claim.—"What I claim therein as new, and desire to secure by letters patent, is the arrangement of the grippers combined with the carrying belts, by which I am enabled to carry in the paper, hold it, and retain it until it is perfected, by which it prints it on both sides and then deposits it; the operations being effected by so combining the sheet apparatus with the inking rollers as to give the carrying belts and grippers an intermitting progressive movement, as described.

I also claim in combination with the printing apparatus, the so arranging of the carrying belts as to return the sheets of paper which have been printed on one side at nearly the same level which they occupied when they received the first impression, they being in both cases at the proper elevation for giving the impression as described.

I claim likewise, the manner in which the grippers are made to open and close by means of a spring operating to force and hold them open, and bolts for holding them when closed, in combination with the closer and opener, substantially as set forth."

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3. For an improvement in the *Cylinder Brush used in the Saw Gin for ginning Cotton;* Ebenezer Carver, Bridgewater, Plymouth county, Massachusetts, January 4.

The patentee says—

"The design of my improvement is to enable the brush to produce a sufficient and regular current of air through the gin so as to dis-

charge the clean cotton through the machine in a better manner than has heretofore been done.

In the operation of the common gin, the brushes usually employed for taking the cotton from the teeth of the saws and discharging it through the gin, are liable to produce eddies and counter currents of air in the gin which interrupts the regular and direct passage of cotton through the machine, and causes it sometimes to collect at the ends of the brush in such quantities as to retard its motion and endanger the machine.

This difficulty I obviate by the application of what I call fans to the ends or heads of any cylinder brush extending from the axis to the outside of the cylinder and standing out or projecting from these heads from one to two or more inches according to the length of the brush.

Claim.—"Having thus described my improvement and its advantages, I now claim as my invention and desire to secure by letters patent, the combination of a cylinder brush having fans on the end thereof, with a cotton gin for the purpose and in the manner herein set forth, or in any manner substantially the same."

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4. For improvements in *Stoves for Heating Apartments;* Henry Stanley, Poultney, Rutland county, Vermont, January 4.

Claim.—"What I claim as new, and desire to secure by letters patent, is the manner in which I have combined and arranged the two stories thereof, consisting of two cylinders, with eight triangular radiating flues arranged around, and in contact with them, said flues communicating with the flue space in the plinth, with the intermediate chamber, and with the cornice space, as described; the two latter being divided by partitions into anterior and posterior portions, in the manner and for the purpose set forth; and there being also openings, such as are herein described, and represented, through the upper end of the upper cylinder into the cornice space, in the manner and for the purpose above made known; it being distinctly understood, that I do not make any claim to either of the individual parts taken separately and alone, but that I limit my claim to the combination and arrangement thereof as a whole: not intending however, by this claim to confine myself in constructing my stove to the particular form of the respective parts as described and represented, but to vary these as I may deem expedient, whilst I attain the same end by means substantially the same."

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5. For an improvement in the *Cooking Stove;* Charles Wolff, Cincinnati, Ohio, January 4.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the two horizontal flues, in combination with the ovens, their bottom plates forming parts of the top of the oven, their inner plates forming partly two sides of the same, their top plates being formed by the hearth plate, and their outside plates by the side plates of the stove. I do not claim merely to conduct the heat

all around the oven, but I do claim the particular arrangement of the flues to effect the said object as herein above described.

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6. For an improvement in the mode of *Arranging a Reciprocating Steam Engine to turn two parallel shafts;* J. H. Towne, Philadelphia, Pennsylvania, January 10.

The following is extracted from the patentee's explanation, viz:—"The engine is to have a vibrating cylinder, sustained upon suitable trunnions, through which, if desired, the steam may be admitted into the cylinder, but it may, if preferred, have other provisions for the admission of steam, which need not be described, as it is not intended to make claim to any particular manner of doing this, but to use such as are already known, or which may be hereafter devised.

In my engine there are to be two piston rods in a line with each other, which rods are to pass through the two cylinder heads, each head being provided with a stuffing box. The piston rods are each to be connected with a crank at their outer ends, so that each actuates the shaft of a wheel for propelling, or for any other purpose, and cause said shaft to revolve in opposite directions.

One of the connexions of the piston rod with its crank is to be made by the aid of a link, or of a sliding box, admitting of a slight degree of lateral play, to prevent cramping as the cranks revolve."

Claim.—"I claim therein as new, and desire to secure by letters patent the manner in which I have arranged the same so as to connect two piston rods, proceeding from one piston to two driving shafts, for the purpose of turning them simultaneously in the opposite direction as set forth. I likewise claim in combination with the two piston rods, the connecting of one of them to one of the crank pins, by means of a link, or some equivalent devise, allowing of the amount of the lateral motion necessary to enable both cranks to revolve with perfect freedom.

I do not claim the passing of the two piston rods through the two heads of a cylinder, as in itself new, this having previously been done: but I limit my claim to the combination and arrangement by which I effect the object that it was the purpose of this invention to accomplish, as set forth, and applied to the vibrating cylinder steam engine."

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7. For an improvement in the machine for *Planting Potatoes*. Enoch Woods, Beloit, Rock county, Michigan, January 10.

This machine consists of a plough for opening the furrow, two reversed mould boards, for forming the ridges, a hollow tooth for opening the drills and conducting the seed to the drills, and these are all followed by coverers and a roller. The planting apparatus consists of a pricker which pricks into the potatoes, lifts them up from the hopper, and carries them against a scraper by which they are removed from the pricker, on its back movement, and dropped into the tube of the hollow tooth and thence conducted to the drills. The lever of the pricker is operated by pins on a wheel, receiving its motion by a belt from the axle of the carrying wheels.

Claim.—"What I claim as my invention, is the combination of the apparatus for dropping or planting potatoes, with the apparatus for ploughing the ground, opening the drills, and covering the seed, as described."

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8. For a machine for *Backing Books, for Book-binders;* William Laighton, Portsmouth, Rockingham county, New Hampshire, January 10.

The patentee says—"The operation of backing consists in giving that roundness or convexity to the back of the book which is necessary to prepare it for the reception of the covering of leather or other material. This process is usually performed by confining the book after it has been stitched and cut, between suitable boards or plates of metal, which are pressed firmly together by means of screws, and the back is then hammered into the desired form. In my machine, the book to be backed is confined between two plates, or jaws of iron, which is made to clasp it firmly, as if between the jaws of a vice, and these plates are so arranged as when closed to constitute a carriage, which, by means of a rack and pinion, is moved on in a straight line, so as to bring the back of the book against a roller, or against a block of iron, or other metal; when a roller is used it is made hollowing or concave on its periphery, and is so adjusted as to force the back of the book to assume the desired convex form, leaving it perfectly straight from end to end, and giving to it an equal convexity in all its parts. When, instead of the concave roller above named, I use a block of iron or other metal, which is made to occupy the place of the roller, said block has that side of it which is towards the back of the book, made concave, or hollowing lengthwise, and the back of the book as it is passed along being made to press against the block, receives the desired form; this latter manner of forming the instrument possesses some advantages over the roller, and will probably be generally preferred.

Claim.—"What I claim therein as new, and desire to secure by letters patent, is the manner herein described of causing the back of such books to be carried along against a fluted roller, or block of metal, whilst they are confined between the jaws of what I have herein denominated the backing irons, the respective parts of said machine being arranged and operating substantially as herein fully made known."

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9. For an improvement in machinery for *Making Pelisse Wadding, or Batting;* Oliver Tenny, Dorchester, Norfolk county, Massachusetts, January 10.

In this machine the bat is sized without an endless apron. It passes directly from the sizing rollers over a small roller at one edge of a vertical chamber, descends nearly to the bottom thereof, and then up again over another roller at the other side of the chamber, and is there delivered and rolled up. A stove is placed at the bottom of the chamber and communicates by a pipe with a long drum near the top, the sides of which with the upper part of the chamber, which is cur-

rowed for this purpose, constitute two passages or flues for the heated air at each side of the bat as it enters and leaves the chamber.

Claim.—"What I claim consists, in the manner in which I effect the drying of the sized bat without the employment of chain aprons or conveyors, such as are generally used therein, viz. by means of the long vertical apartment (for the reception of the bat and hot air) and (in combination with) a passage or flue (for the discharge of the air in a current) proceeding from the upper part thereof; the same being arranged with respect to the size rollers, and the bat being carried through the said passage and into the hot air apartment, and out of the latter through a passage or outlet, and received and wound upon a beam substantially as described."

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10. For improvements in the apparatus for *Working a Vertical Forge Hammer;* George E. Sellers, Cincinnati, Ohio, January 10.

The essential feature of this invention is, for working the hammer by means of two rollers, that receive motion from a steam engine, or other motive force, one of which has its bearings in permanent, and the other in movable boxes connected with a toggle-joint or other lever, so arranged as to force this roller towards the other, and gripe a square rod on the hammer to lift, and then separate them to liberate it—the toggle joint lever being connected with the roller by means of a powerful spring; and the mechanism that operates the toggle so arranged as to enable the attendant to regulate the play of the hammer at his discretion, to strike a light or heavy blow, as the condition of the iron may require.

Claim.—"What I claim as new, is the manner of operating upon the lifting rod by means of the friction drums, one of which is made to advance to, and to recede therefrom, by being placed on a sliding frame which is operated upon by a toggle joint, under an arrangement of parts substantially the same with that herein described. I also claim the manner of arranging the respective levers, the catch, the cam wheels, and their appendages, so as to be operated upon by the lines and chains attached to the said levers, substantially as described.

"And I do hereby declare that I do not intend by these claims, to limit myself to the precise form and disposition of the respective parts of said machine, but to vary these as I may think proper, whilst I attain the same end by equivalent means."

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11. For an improvement in the *Buckle for Connecting Straps;* Kasson Frashure, Manlius, Onondaga county, New York, January 16.

This buckle fastens the straps together without a tongue, and is called by the patentee the "*Angular Box and Grooved roller Buckle.*" The lower plate, which is attached to one of the straps, forms with the upper one an angle, so that at one end they are nearer together than at the other; this constitutes what is termed in the specification the angular box. The upper surface of the lower plate of this box is grooved, and on it runs a grooved roller, the grooves of each fit-

ting into each other like cogs. The strap to be fastened is passed between the top plate of the angular box and this roller, so that the more the strap is pulled, the tighter it is squeezed by the turning of the roller against the upper plate. The angular box is provided with the requisite loops for retaining the straps in their proper directions. The roller is connected with the lower grooved plate of the angular box, by a strap which embraces the middle part of the roller, reduced in size for that purpose, and passes down through a slot in the plate and is there provided with a plate.

Claim.—"What I claim as my invention, is the construction and use for all similar purposes with other buckles, of the following parts of my angular box and grooved roller buckle, to wit, said grooved roller moving upon the grooved surface of the back section of the angular box, and the manner of its attachment to said back section by means of a loop or ring, and a slide, so that the same retains its place and acts upon the strap required to be held by pressing it against the bridge or front section of said angular box, and any and every thing essentially the same: all other parts of said buckle being disclaimed as like, or similar, to those of other buckles now in common use."

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12. For an improvement in *Buckles, or Apparatus for Connecting Straps;* Charles F. Beverly, Salem, Columbiana county, Ohio, January 16.

This differs from the preceding only in the use of a lever for the roller, so arranged, that, as the part which bears upon the strap, and which is notched for that purpose, is drawn forward by the strap, a catch on the upper surface of the lever is received in a lower tooth of an inclined rack attached to the grooved bottom plate, and thus the lever is caused to gripe the strap the tighter.

Claim.—"What I claim is the method of fastening together the ends of straps and other articles by a combined hinged convex lever and serrated plate, and adjustable sliding bar, whether constructed and arranged in the manner set forth, or other mode substantially the same."

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13. For an improvement in the *Press for Compressing Cotton, Hay, &c.;* Philos B. Tyler, New Orleans, Louisiana, January 16.

The nature of this invention consists, in applying power to the compression of cotton, or other substances, through the intervention of two sectors, gearing into a double rack, or connected with the piston rod by connecting chains in a manner well known to all mechanics, attached directly to the piston of a steam cylinder, and connected with the platen by the means of two bars or rods, said connecting rods being attached to the sectors at a point within their circumference, which when they revolve by the action of the racks, raise the platen with a power increasing in the proportion, or nearly so, of the increased resistance of the material under pressure.

Claim.—"What I claim is, the arrangement of the sectors and double rack piston rod in combination with the follower of the press, by means of the connecting rods, to adapt the movement of the platen or

follower, to the increased resistance of the cotton, and thus attain the greatest amount of effect, with the least expenditure of power, as described."

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14. For an improvement in *Water Wheels;* James Gardner, South Lee, Berkshire county, Massachusetts, January 16.

Claim.—"What I claim as my invention, is the manner in which I construct my water wheel—that is to say, the form of the buckets having two distinct curves, one of the curves projecting beyond the periphery of the wheel into spiral shutes; the curves on the face and back of the buckets corresponding; and in combination therewith the openings in the bottom of the spiral shutes for the discharge of the water."

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15. For an improvement in the *Endless Floor for Horse Powers;* Luke Hale, Hollis, New Hampshire, January 16.

This is for a method of forming and uniting the chains of an endless floor for a horse power.

The claim is in the following words, viz. "I shall claim the mode of firmly uniting together by one screw bolt the several parts of the three links, B, C, C, and the floor board, viz. by a combination of ears *d, e,* cast upon the inner sides of the two portions of the link B, so as to lap over each other and permit the screw bolt to pass through them and operate upon and with respect to the several parts, as described."

The link, designated in the above claim by the letter B, is composed of two plates of metal, the ends of which are provided with holes to receive and embrace journal or joint pins on the ends of the two links C, C, one at either end, and these two plates are cast with ears *d, e,* that lap on each other so that a bolt passing through a hole in them, and through the end of the floor board, secures the whole together.

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16. For an improvement in *Piano Fortes for producing the harmonic Tones;* Lesley Walker, Carlisle, Cumberland county, Pennsylvania, January 16.

"The nature of my invention consists in producing harmonic tones an octave higher than the original sound of the strings of the piano forte, ad libitum, by means of a set of hammers or weights which are placed in a frame over the strings, and are brought down upon them at the centre of their length by a pedal or other analogous device under the piano, similar to what is used at present to control the soft pedal or damper frame."

Claim.—"What I claim as my invention, is an extra set of hammers, weights or dampers, or a continuous bearing, constructed and arranged as described, passing over the centres of the strings of a piano forte, so as to be brought down upon them by a pedal or other analogous device for the purpose of producing the harmonic tones, as set forth."

17. For an improvement in *Railways;* Wm. M. C. Cushman, Albany, New York, January 16.

This improvement is for capping cast iron base rails with wrought iron in a manner to protect the sides of the base rail, and prevent the rails and caps, at the junctions, from moving out of the proper line.

Claim.—"I am aware that cast iron base rails have been capped with wrought iron rails, and therefore I do not claim this as my invention; but what I do claim as new and desire to secure by letters patent, is connecting the cap rails with the base rails, by means of a fillet, flanch, or rebate, as described, so that by breaking joints the base and cap rails will be retained in their proper lines at the joints, and the cap rails may be extended up to or beyond the inner edge of the base rail, and thus prevent the flanches of the wheels from acting against the base rails."

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18. For a machine for *Pulling Flax;* James H. Bennett, East Bennington, Vermont, January 23.

This machine consists of two or more fingers, (like those of a grain cradle) attached to the end of an appropriate handle, on which there is a slide with one or more fingers fitting between those on the handle, and by means of the slide the flax on the field is griped between the two sets of fingers—the slide on the handle being provided with a lever handle, toggle joint, or other analogous device for operating it.

Claim.—"What I claim as my invention, is the manner of grasping the standing flax for the purpose of pulling it, between the fingers or jaws by means of the movable part sliding and receiving its motion in the direction of the handle from the crank neb, by means of a slot and pin, or toggle joint, as described."

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19. For an improvement in the machine for *Boring and Mortising Hubs, applicable to other purposes;* Reuben D. Roys, and Newell French, Detroit, Michigan, January 23.

Claim.—"We claim the combination in the mandrel of a rotary motion for the purpose of boring and drilling, with a vertical motion, for the purpose of mortising, the mandrel taking both motions in the former operation, and the vertical only in the latter."

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20. For an improvement in the mode of *Casting the Bowl on the stand or pedestal in the process of making Glass Lamps;* P. F. Slave, and John Golding, East Cambridge, Middlesex county, Massachusetts, January 23.

In performing this operation in the old method, the pedestal first moulded is put into the mould and the bowl then put on by blowing; but the improvement in question is for the purpose of avoiding this difficulty by having a platform to receive the pedestal of the lamp, and above it a shaft to receive the upper end of the pedestal, and which at the same time forms the base of the mould for the bowl.

Claim.—"We do not claim as our invention combining the bowl of the lamp with the stem thereof by blowing it on, as that has before

been done, but what we do claim is combining the mould for the bowl of the lamp, constructed substantially as set forth, with the horizontal shelf (into which the top of the foot of the lamp is fitted) and the platform on which said foot rests, by which the connexion or cementing of the bowl and foot is accomplished in a truer and more perfect manner than it can otherwise be done, the whole arrangement being substantially as described."

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21. For improvements in machinery for *Making Wood Screws*; Simeon Brooks, and Wm. N. Clark, Chester, Middlesex county, Connecticut, January 23.

In this case we are under the necessity of omitting the claims, as they refer to and are wholly dependent on the drawings, the publication of which, from their necessary complexity, would carry us beyond the limits of this work; but they are limited to the following arrangements. The first section refers to the machine for paring the head of the screw, and consists of the combination of the lever which carries the cutter or tool with another lever connected with it, and a spring the lower end of which embraces the shank of the screw, back of the head, so that by withdrawing the tool or cutter by the hand of the attendant, the second lever is operated which forces the spring back and discharges the screw blank from the jaws that have been opened previously in a manner well known. The second section refers to the machine for nicking the heads, and is limited to an arrangement of parts for presenting the screws to the action of a circular saw on a mandrel by means of a face plate (having holes near its periphery that receive the screw,) operated by a series of levers to insure the cutting of the nick to the required depth, and then to shift the face plate—the whole being performed by the movement of two levers by the hand of an attendant.

And the third section refers to the threading machine, which cuts the threads by means of two roller dies one of them having its bearings in sliding boxes moved by means of a gauge rod to regulate the cut of the threads. This gauge rod is wedge-formed at that part which operates the slide of the die, and is so connected with the spindle of the jaws that carry the screw, as to force the dies together, as the point of the screw approaches them, to cut conical screws. It is to this arrangement and combination of the gauge, that operates the slide with the spindle of the jaws, that the claim is limited.

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22. For improvements in the apparatus for *Generating, Condensing, and Burning Gas from Oil, Resin or Coal, &c.*; Benj. F. Coston, Washington, D. C., January 31.

Claim.—"1st. I claim the method of introducing the resin or fat into the retort by means of the feeder G, and pipe H, and tube H'; as above described, directly on to the coke or other charge in the retort, whereby the disadvantages arising from the collection of sediment in the ordinary syphon tube are obviated, and the resin or oil is introduced into the hottest part of the retort, without any portion coming in contact with the sides.

2nd. I claim the jacket around the pipe that conveys the gas to the condenser, in combination with the cistern of the gasometer, in the manner and for the purpose described, thus keeping the pipe cool and preventing the tar from baking on to said pipe. 3d. I claim the combination of a condenser constructed and arranged, as made known, with the retort, and gasometer, for the purposes herein specified, to condense the gas that passes through it, and having a cistern below to draw the tar into.

"4th. I claim constructing the gas burner in the manner described, having a long double tube with a conical chamber above it as specified, so as to heat the gas to a high temperature before burning.—Lastly. I claim the mercurial joint, constructed and arranged substantially as set forth, for passing gas from a stationary to a revolving pipe, as described."

The above claim refers to the drawings, and as they are too numerous to admit of publication within the compass of our notices of patents, we will explain the nature and functions of the parts simply indicated by letters.—Section first. The pipe H, is a pipe extending up from the top of the retort, closed at top, and having another and smaller pipe H' passing through it and extending down about half its length, and extending up into and near to the top of a small cylindrical feeder G, above it, and from near the bottom of this feeder another pipe extends up to the cock of a kettle that contains melted resin or fat. Section second. The pipe J, for conducting the gas from the retort to the condenser, is surrounded by a jacket through which a stream of water passes from the condenser to keep the pipe J, cool. And section last. The mercurial joint of the stationary and revolving pipes is thus formed: The end of the revolving pipe rests on the other by a pivot, and both are pierced with holes, surrounded by a double cup, half of which is attached to each pipe, so that a flanch from the upper one will dip and run in a groove or channel in the under one, made of such depth as to contain a column of mercury, sufficient in height to resist the pressure of the gas, which by this arrangement escapes from the holes in the end of one pipe and passes in to the other—the mercurial cup preventing its escape.

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23. For improvements in the machine for *Reaping Grain*; Cyrus N. McCormick, Rockbridge county, Virginia, January 31.

This is for improvements on that kind of machines in which the grain is cut by the serrated edge of a straight and vibrating cutter, operated by a crank, the grain being sustained by fingers. The blade is serrated like a sickle except that the angle of the teeth is reversed for every alternate tooth, and the supporters of the blade are secured by screws to the front part of the platform, and bent down and then up to give a free escape to straw which may enter the machine.—The fingers for supporting the grain are spear-formed and the angle of the edge begins to run in forward of the edge of the cutting blade, so as to form an angular shear to insure the support of the grain in the act of cutting. The other improvements are fully pointed out in the following claim.

Claim.—"I claim 1st the curved (or angled downward for the purpose described) bearer, for supporting the blade in the manner described.

"I claim the arrangement and construction of the fingers or teeth for supporting the grain so as to form the angular spaces in front of the blade, as, and for the purpose described.

"I claim setting the lower end of the reel post behind the blade, curving it and leaning it forward at the top, thereby favoring the cutting and enabling me to brace it at the top, by the front brace, as described, which I claim in combination with the post."

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24. For a composition of matter for *Lubricating the Rubbing Surfaces of Machinery;* Increase S. Hill, and Joseph Dixon, the former of Boston, and the latter of Taunton, Massachusetts, January 31.

The patentees say, "Our composition consists mostly of zinc, (which as is well known belongs to the class of cheaper metals) hardened by being compounded with what we denominate a *hardening composition.*

"This latter composition is formed of the following metal, mixed in a state of fusion in the proportions hereinafter specified, viz. fifteen parts of tin to thirty-five parts of copper.

"This composition in a state of fusion is to be mixed with molten zinc and tin, (although tin is not absolutely essential) in the proportion of the *two* parts of the said hardening composition, of *nineteen* parts of zinc, and from three to five parts of tin, according to the peculiar purpose for which the composition is to be used, the tin specified to be added last, having the tendency to render the compound when cold more or less ductile, according to the quantity of the same incorporated therewith. The metal formed without the addition of the last named proportion of tin, when broken, will have the appearance of cast steel of coarse quality, but the addition of tin will make it stronger and cause it to be finer in grain until four parts of the same will be added, when the appearance of the metal on its being broken, will be like that of fine cast steel and more closely resemble the same than any other metal.

"The great strength of the composition combined with a certain degree of softness which it possesses, renders it highly useful in the construction of bearings for rubbing surfaces of machinery, as it is capable of resisting for a great length of time, the effects of wear and attrition. The large proportion of zinc used in forming the compound renders its use in the mechanical arts, much less expensive than the metal ordinarily employed for these purposes, the cost being much less than any other composition in which copper and tin are the principal metals.

"What we claim as our discovery, and desire to have secured to us by letters patent, is the composition or compound metal formed by the admixture of the above specified proportions of *zinc*, and *hardening* composition described, whether tin *be superadded* in the proportions described or not."

25. For an improvement in the machine for *Drilling, &c., Iron, &c.;* Aretus A. Wilder, Detroit, Michigan, January 31.

The mandrel has a rotary as well as an endwise movement, the latter being communicated by a screw on the mandrel which passes through a nut on a cog wheel. The mandrel also slides through another cog wheel which gives to it the rotary motion by a feather, and this cog wheel takes into another cog wheel on one end of a shaft, parallel with the mandrel and having another cog wheel on the other end taking into the cog wheel on the nut, so that by giving different diameters to these wheels the mandrel with its drill will be moved forward with any desired degree of velocity; but for the purpose of running back the mandrel very fast, the nut has notches in its periphery, into which a dog falls to prevent it from revolving, and at the same time another dog catches on the frame and retains it in place, this is effected by the movement of a lever which at the same time gives an endwise movement to the shaft of the wheel that communicates motion to the nut for the purpose of throwing this out of gear.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the lever and cogs with the nut and shaft, for stopping the nut and throwing the wheel out of gear, as herein set forth."

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26. For improvements in the *Plough;* Bancroft Woodcock, Wheeling, Ohio county, Virginia, January 31.

The reversable joint and share of this plough are secured by a wedge for each. The back end of the point passes between the under side of the mould-board and a staple, which extends from the land-side to the mould-board, and then a wedge is driven in between this staple and the under side of the point, and the reversable share has a mortise which passes over a tenon projecting from the under side of the mould-board, and so notched as to receive a key.

Claim.—"What I claim therein as new, is the manner in which I have given stability to the respective parts of my plough, by securing the same together by the means herein set forth: that is to say, by the combined action of the staple and wedges of the projections on the point of the hooked knob, and its wedge, arranged and connected with the other parts as set forth, by which arrangement and connexion of the respective parts, I have those parts which are to bear the main strain and shocks in a form which insures the necessary strength, and prevents them from moving out of their places.

"I do not pretend to claim the use of hooks, mortises, or wedges, but limit my claim as above set forth, to the particular manner in which I have arranged these in my improved plough.

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27. For an improvement in *Ships' Augers;* Wm. N. Clark, Chester, Middlesex county, Connecticut, January 31.

The upper edge of the single twist auger is made concave, instead

of convex, as heretofore, to give a cutting edge along the entire length of the twist, to assist in clearing the auger.

Claim.—"What I claim as my improvement, and desire to secure by letters patent, is the mode of making the single twist ship auger, the bit and gimlet, with the upper inner surface of the twist *concave*, as above described, and for the object set forth."

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28. For an improvement in the apparatus for *Felting Cloth;* John Andrews, Bellville, Bergen county, New Jersey, January 31.

This improvement is for subjecting the felt to the action of moist and dry heat at the same time. The bed or box on which the bat is felted by the platen or rubber, is hollow and provided with pipes to admit steam to heat it, and this communicates with another steam box, the top of which is pierced with small holes for the escape of steam to that portion of the bat which rests on it before it passes to the rubber to be felted.

Claim.—"What I claim and desire to secure by letters patent, is the manner herein described of combining and arranging the steam box with its perforated top, the second steam box in the rear thereof, and the reciprocating platen and rubber by which it is surmounted, so as to co-operate in the process of felting, in the manner set forth.

"It will be manifest that a single steam box might be made to answer the purpose of the two, but the two are preferred, as being less cumbrous, more easily made, and answering the purpose better than one of double size."

Patents Re-issued in the month of January, 1845.

1. For the *Management and Generation of Heat in the Manufacture of Iron;* C. E. Detmold, of New York, assignee of Von Faber Du Four, of Wertemberg,—granted April 16, 1842, to run fourteen years from the 12th of May, 1841, the date of the first patent granted abroad—January 2, 1845.

The original patent for these improvements belongs to the hiatus in our list which we hope soon to fill up, therefore we shall simply insert the claims under the re-issued patent, for the benefit of those who have made themselves acquainted with this valuable invention.

Claim.—"I claim the collecting and drawing of the combustible gases, chiefly consisting of carbonic oxide gas, from blast and other furnaces, at one or more points below the top of the fuel in said furnaces, substantially as set forth, for the purpose of employing said gases instead of other fuel, for heating all kinds of furnaces used in various processes of manufacturing and working iron or any other metal, and for heating steam boilers or any other structures requiring a high temperature. I claim the above described mode or any other substantially the same, of generating combustible gases from any kind of fuel in separate furnaces or chambers, and conducting the same to other furnaces or structures that are to be heated by the combustion of said gases.

"I claim the mode, or any other substantially the same, of forcing through a system of blow pipes or in any other convenient manner, heated air in numerous small streams and under a pressure greater than that of the atmosphere, into the said combustible gases in the furnaces or structures, where the same are to be used for the purpose of producing by the rapid and intimate mixture of the heated air with the combustible gases, their immediate and complete combustion."

List of American Patents which issued in the month of December, 1841, *with Remarks and Exemplifications.* By CHARLES M. KELLER, late Examiner of Patents in the U. S. Patent Office.

(Continued from Page 109.)

23. For improvements in *Propelling Vessels*; Thomas J. Wells, New York city, New York, December 23.

The propellers, two in number, are arranged with their axes in the direction of the length of the boat, and therefore parallel to each other, and are pointed at each end, and in their general form resemble a segar; they are sustained on journals at each end, and are provided with spiral paddles along a portion of their entire length. It is proposed sometimes to make use of these propellers as the only means of giving buoyancy, and at others to add, to assist them in this office, a partial hull or hulls.

Claim.—"What I claim therein as new, and desire to secure by letters patent is the employment of buoyant screw propellers for steamboats, so constructed and arranged as that they shall constitute buoyant portions of the boat, which propellers may in this case be nearly or entirely submerged.

"I also claim the use of such propellers, so arranged and combined with the boat, as that the hull of the boat itself shall dip in the water and concur with the propeller or propellers in giving the whole construction the requisite degree of buoyancy, the said propellers and boat being constructed and arranged substantially in the manner herein set forth. And I do hereby declare that I do not claim the use of buoyant propellers generally, such propellers having been used, or proposed to be used, with their axes crossing the boat, but I limit my claim to the use of buoyant screw propellers, placed like other screw propellers, in the direction of the length of the boat, as herein set forth."

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24. For improvements in the *Syphon for Transferring Liquids*; George Johnson, New York city, New York, December 23.

The first improvement claimed is for charging single or double syphons by means of a bulb connected with the upper part or bend of the syphon, the bulb being of sufficient capacity to contain as much water as will fill the syphon. The second improvement claimed is for shielding syphons against reaction when one leg is to be used in

warm water, by means of a shield or sleeve surrounding the leg of the syphon. And the third improvement claimed, is for the manner of combining the bulb with a double syphon by means of a tube passing from the inner syphon through the neck of the bulb which is of sufficient capacity to form the communication with the outer syphon around this tube.

We are under the necessity of omitting the claims, as they refer to the drawings.

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25. For an *Ignitable Compound for Friction Matches;* Norman T. Winans, Theodore Hyatt, and Thaddeus Hyatt, New York. December 23.

The disclaimer and claim on which this patent is granted, will give the reader a clear notion of the nature of the invention, viz: "What we claim therefore is not glue rendered damp proof by being chemically united with shellace, as this is an old discovery in the arts. Nor do we claim the union of glue and phosphorus either alone or with other inflammables, as these have been known and used for years.—But we do claim phosphorus either alone or in connexion with other inflammables in combination with glue or gum rendered damp proof by being chemically or mechanically united with shellace for the use and purposes set forth."

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26. For an *Inflammable Compound for Friction Matches;* N. T. Winans, Theodore Hyatt, and Thaddeus Hyatt, New York, December 23.

As in the preceding we deem the disclaimer and claim sufficient.

Claim.—"We do hereby declare that we do not mean to limit or confine ourselves to the precise proportion of the respective ingredients used by us, as this may be varied to some extent without changing the nature of our improvement, nor do we claim the using of a solution of shellace or other resin as a part of this compound, when such solution is made by means of alcohol or spirits of turpentine; but we limit our claim to the employment of an aqueous solution of the resin made by the agency of an alkili or the salt of akali prepared as described, in combination with phosphorus, substantially in the manner and for the purpose made known.

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27. For improvements in the *Cooking Stove;* Eli C. Robinson, Troy, Rensselaer county, New York, December 30.

The claims in this case refer to and are wholly dependent on the drawings, and therefore, we shall omit them, as we do not deem this of sufficient importance to introduce them. The claim is to the method of combining the stove with an elevated oven, whether rotary or sliding, in such a manner as to preserve the communication with the chimney. In the rotary, the elevated oven is connected with the rotary top, and the escape pipe in the elevated oven is placed in the middle and turns in a collar attached to the permanent frame, in which the whole rotates. And in the sliding oven there is a plate

with a short pipe fitting into the permanent chimney, and this plate is provided with flanches that fit in the top of the sliding oven, to admit of its movement without cutting off the smoke passage.

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28. For an improvement in the *Candle Mould;* James Gamble, and Joseph S. Hill, Cincinnati, Ohio, December 30.

This improvement is for surrounding the candle mould with a water chamber, to cool the tallow as soon as it is poured in the mould.

Claim.—"What we claim as new, is the application of cold water to the candle moulds, in any quantity at one operation by inserting the moulds permanently (or not) in a water tight chest, which can be filled and drawn off at pleasure."

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29. For an improved method of *Cleaning the Rails of Railways of Snow, Ice, Sleet, &c.;* Henry M. Naglee, and Thomas Raney, Philadelphia, Pennsylvania, December 30.

The device covered by this patent is a scraper attached to the front and rear of a locomotive by a joint, and running down to the rail at any inclination, which scraper is made in two parts jointed together, and pressed upon the rail by a spring; when the scraper meets with an obstruction which cannot be moved, the joint yields and passes over it.

Claim.—"What we claim as new, is the arrangement or combination of the iron bar, with joints, and springs, so that the machine will be self-acting, and operate in the manner set forth."

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30. For an improvement in the *Horse Power;* John A. Toplin, Hammond, St. Lawrence county, New York, December 30.

We have here a method of making large or master cog wheels for portable horse powers in segments. The rim of the wheel is made in parts with tongue and groove joints to insure the accurate fit, when put together, and then a staple is inserted from the outer periphery with one stem passing through a hole in each segment, and passing through to the inner periphery, and there secured by nuts. To give additional stiffness to the connexion, the body of the staple fits in a groove in the outer periphery of the wheel.

Claim.—"I do not claim as my invention, the making of a large cog wheel for a horse power in segments; but what I do claim as my invention is the making of the large or master wheel of a portable horse power in segments when united by clamps, as herein described."

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31. For an improvememt in the machine for *Thrashing and Separating Grain;* Ashley Townsend, Le Roy, Genesee county, New York, December 30.

Back of the thrashing cylinder there is a revolving rake, and below it a concave rack through which the grain passes as the straw is raked off; and below the rack an inclined plane, which conducts the grain, after it has fallen from the concave rack, to a shoe and screen which receive wind from a rotary fan. Beyond the inclined plane just men-

tioned, there is another inclined plane, designated by the letter M, and above this an endless belt of slats, on which the straw is thrown by the revolving rake, for the purpose of carrying off the straw, and discharging the remaining grain on to the inclined plane M, which conducts it to the screen and shoe.

Claim.—"What I claim as new, is combining the raking cylinder, concave rack, and inclined plane, with the shoe, the screen, and fan, as set forth. Also in combination with the foregoing, the inclined plane M, and endless belt or revolving apron of slats, all as set forth."

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32. For an improvement in the *Inkstand;* George Burnham, Philadelphia, Pennsylvania, December 30.

Claim.—"What I claim as new, in my improved instand, and desire to secure by letters patent, is the employment of a gum elastic bottle or other analogous elastic substance to constitute the body, or reservoir, of the instrument for the reception of the ink, in combination with a tubular shaft passing through said elastic bottle, which shaft is furnished with a cup at its upper end into which the ink from the bottle may be forced at pleasure, by the pressure of said bottle, and from which it may be again withdrawn, by allowing the bottle to expand, the whole apparatus being constructed and operating substantially as described and made known."

We deem any explanation unnecessary, as the character of this invention is clearly pointed out in the claim; this inkstand is very extensively used.

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33. For an improvement in *Propelling Vessels;* Peter Lear, Boston, Massachusetts, December 30.

In a horizontal semi-circular chamber at the stern of the vessel, there is a paddle attached to a vertical shaft in the axis of the semi-circular case, so that by the vibration of the paddle, the water is alternately acted upon on either side of the shaft.

Claim.—"I shall claim arranging in the counter or other suitable part of a vessel, the semi-circular box having a vertical paddle affixed to a shaft placed in the centre of the curve of the box, (and connected with suitable machinery so as to move alternately back and forth) as described, the whole being arranged and operating substantially as hereinbefore set forth."

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34. For an improvement in the *Fastener for Window Shutters;* Thomas C. Cary, Poughkeepsie, Duchess county, New York, December 30.

This is for an improvement in the lever catch attached to the shutter, so as to fasten it when open, as well as when shut. The catch that is inside, when the shutter is closed, opens the other, but cannot be opened by it. The two lie one above the other, in the mortise, and the lower face of the bottom one is notched and the upper face of the upper one, and when introduced into the mortise of the plate attached to the shutter, these notches become the pivots on which they turn.

Claim.—"What I claim as my invention, is the manner of confining the latches to their places, by means of the notches on the shanks thereof, fitting into the upper and lower edges of the mortise in the plate, for the purpose and in the manner specified."

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35. For improvements in the machine for *Finishing Silk from the Cocoon;* Thomas White, Mount Pleasant, Jefferson county, Ohio, December 30.

Claim.—"What I claim as my invention, is, 1st. Constructing the reel in sections so that each section will wind a single strand, and when filled that the sections can be separated and removed to another axle, for the purpose of spooling, as described. 2nd. The combination of the ratchet wheels, axles, and bent wires, for stopping the motion of the spools placed on said axles, when the silk breaks in doubling it, as described."

The first section of this claim is sufficiently clear to need no further explanation; and as to the second, it is only necessary to add, that the bent wires have a loop at one end, through which the silk passes, and the other is so formed as to fall into the rachet teeth on the spools, and stop them when the silk breaks.

Specification of a Patent for preventing and removing Incrustation in Steam Boilers, granted to Antoine Ritterbandt, M. D., *of Poland, but now residing in Great Britain,* Sept. 10, 1845.

To all whom it may concern: Be it known that I, Louis Antoine Ritterbandt, have invented "improvements in preventing and removing incrustation in steam boilers and steam generators;" and I do hereby declare, that the following is a full and exact description thereof.

The incrustation of steam boilers and steam generators when fresh water is used, arises chiefly from the heat employed to generate steam, causing the lime which exists in the water in the form of a soluble bicarbonate of lime, to be converted into an insoluble carbonate of lime; the particles of which, as they fall towards the bottom, carry down with them masses of other insoluble matters, which may be floating in the water. And when salt or sea water is employed, as in marine boilers, incrustation is generally promoted by the carbonate of lime set free by the heat, which, as it floats in the water previous to subsidence, forms nuclei for the accretion of other matter, and disposes the saline compounds, such as the sulphate of magnesia, chloride of sodium, &c., to crystallize and precipitate much sooner than they otherwise would. Now the nature of my invention consists, in the former case, either in preventing the formation of carbonate of lime, or in converting it when formed into a soluble salt; and in the latter in retarding the formation of the saline crystals, and thereby also retarding the precipitation of other floating matter which would produce incrustation. Thus in both cases the waste of heat and the destruction of the metal ordinarily arising from incrustation, and from the frequent blowing off which is had recourse to, is in a great measure

obviated. The manner in which I effect these objects, I will now proceed to explain.

Although when lime exists in the state of a bicarbonate it is perfectly soluble, but easily converted by heat into an insoluble carbonate, and so precipitated, yet there are other salts of forms of lime which remain in solution as long as the water is not over saturated with them and remains in a heated state. Among these soluble salts are the hydrochlorate or muriate of lime, or, as it is sometimes also called the chloride of calcium, also the acetate of lime and the nitrate of lime. By converting therefore the insoluble carbonate of lime either into a muriate, or acetate, or nitrate, or other soluble salt of lime, it assumes a condition in which it is not precipitated by the heat, and neither incrusts the boiler itself, nor contributes to its incrustation by promoting the crystallization or precipitation of other matters. To effect this conversion, I introduce into the water in the steam boiler or steam generator, or into the supply tank connected with it, some ammoniacal salt, the acid of which uniting with lime as a base, will form a perfectly soluble salt of lime, not decomposed or separated by heat. The ammoniacal salt thus to be employed may be, either the muriate of ammonia (called sometimes the hydrochlorate of ammonia, also chloride of ammonium, and commonly known by the name of sal ammoniac,) or the accetate of ammonia, or the nitrate of ammonia, or any other ammoniacal salt, whose acid forms with lime a soluble compound. I prefer the muriate of ammonia, because of its cheapness, it being easily obtained from various animal and mineral substances existing in great abundance. It is not necessary to employ this salt in a state of purity, the inferior crystals before purification and sublimation serving sufficiently well the purpose of my invention. The quantity of the ammoniacal salt to be employed will depend on the quantity of lime contained in the water in the form of bicarbonate.—This can be readily ascertained by chemical analysis; and I would recommend the following plan for the purpose, as from its simplicity it can be practiced by any working engineer.

Take a gallon, or any other measure of the water to be examined, and evaporate it slowly in an open vessel: Collect the solid matter left at the bottom of the vessel, and weigh it carefully. Then add to it in a glass vessel, a mixture of equal parts of muriatic acid and distilled, or rain water, and let it remain during fifteen minutes. Next, filter through white filtering or blotting paper, or strain through clean linen or calico. Collect the solid matter left in the filter and dry it; the difference between its weight now and before, will give the amount of carbonate of lime dissolved in the muriatic acid. Thus if a gallon of water gives ten grains of solid matter, and after digesting with muriatic acid there are only six grains left, the gallon contains four grains of carbonate of lime. Having thus determined the quantity of lime in a gallon of water, I would recommend the muriate of ammonia to be used in the same quantity, or rather a little in excess, as at the rate of fifty-four of this ammoniacal salt to fifty of the carbonate of lime. If the acetate of ammonia be employed for the purpose of my invention, the preparations must be about forty parts of the saturated

solution, to about fifteen parts of carbonate of lime. What I mean by saturated solution is one prepared by adding carbonate of ammonia to acetic or pyroligenous acid, or to distilled vinegar until no more is dissolved. If nitrate of ammonia be employed, the proportions must be eighty parts of the crystals to fifty parts of carbonate of lime; of course in every case the amount of water evaporated in a given time must be taken into account, as in proportion to the water evaporated will be the carbonate of lime set free and the quantity of the ammonical salt required. The action of the muriate of ammonia (which for the reason before given I prefer) is partly chemical and partly mechanical. First, it is chemical, inasmuch as after the introduction of the salt into the water, a double decomposition takes place. The muriatic acid combines by elective affinity with the lime to form muriate of lime, while the carbonic acid passes to the ammonia and forms carbonate of ammonia. The former, or the muriate of lime, remaining in a state of solution, and the latter, or the carbonate of ammonia, volatilizing under the influence of the heat, and passing off along with the steam. This decomposition, however, goes on slowly and gradually. When the salt is added in considerable quantities at a time, it remains in part in the state of a muriate of ammonia, until fresh supplies of water, containing additional quantities of carbonate of lime to be decomposed, are introduced. In practice therefore it will be found of great advantage so to use the muriate of ammonia, that is, to add it to the water in considerable quantities at a time, since in this way one application may suffice for several days, or even weeks; this however, will depend on the quantity of carbonate of lime in the water and the rate of evaporation. The mechanical action of this salt (as also of the acetate or nitrate or other salts of ammonia, as before stated,) consists in its increasing the density of the water (without however affecting its clearness) aud thus assisting to retain in a state of suspension any foreign matter which would otherwise sink to the bottom, and there form a solid incrustation. In case of fixed boilers, the salt is conveniently supplied through the manhole, or injected in a state of solution. In locomotive boilers, the material may be placed in the tank, and must be renewed according to the amount of water evaporated per diem, and the lime present in the water.— When it is required to free steam boilers or steam generators from old incrustation, I use the muriate of ammonia or any of the ammonical salts (whose acids will, with lime as a base, form soluble compounds) in much larger quantities, say double or even treble the proportion described, when the salt is used for preventing only; and when the old incrustation is difficult to remove by these means, and does not readily yield to them, besides the ordinary proportion of ammonical salt before described, I pour once a week into the boiler or supply tank which has been previously filled with water, a quantity of muriatic or nitric acid (but I prefer the former) in the proportion of one pint to one hundred gallons of water;* renewing the

* Or if the acetic acid be used, in the proportion of one quart to one hundred gallons of water; or if common vinegar be employed, in the proportion of one gallon to one hundred gallons of water.

operation once a week, until the incrustion is removed. When these ingredients are introduced into the boiler, it is advisable that the engine should be off work.

And having now described the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim, is, first, the application of ammoniacal salts in the manner before described, to prevent and remove incrustation in steam boilers and steam generators. And secondly, the use of ammonical salts in *conjunction* with muriatic, acetic, or nitric acid, for the purpose of removing old incrustation, in the manner above described.

MECHANICS, PHYSICS, AND CHEMISTRY.

On the different varieties of Sugar, and allied substances, with reference to the practical application of their Optical relations. By VENTZKE.

Translated from Erdman's Journal der Pract. Chemie, vol. xxv, p. 65, by J. C. Booth, and M. H. Boyé, and communicated to the Journal of the Franklin Institute, by Prof. R. S. McCulloh.

I. *On the Circular Polarization of aqueous solutions of Sugar.*—This beautiful discovery of Biot, is equally interesting to the chemist and the technologist. The following contains a description of the apparatus employed for this purpose, and the method of using it.

Description of the Apparatus.—In all the figures similar letters indicate similar parts.

A. fig. 1, plate 1, is a firm stand, to which is attached by the hinge C, a board B, B, 18 inches long, 2 inches wide, and ½ an inch thick: so that it may be fixed at any angle with the horizon. On this board is fixed, 1. a wooden support K, with a circular perforation, and a round disk D, fastened to it by screws; in the middle of which a Nichols' prism is fixed, as shown in E'. These prisms are made by grinding the natural rhombohedron (Figs. 4, and 5) of Iceland spar, whose surfaces of cleavage, *g*, *e*, and *f*, *h*, form an angle of over 70°, in such a way that they have 68°: after which the rhombohedron is cut through perpendicularly to the main section of the crystal, and at right angles to the new terminal plane, as shown by *e*, *k*, *f*, fig. 5, (natural size) being the side view, and fig. 4, the front view. These oblique sections are first finely polished, and then again glued together with Canada balsam, by which the desired object is obtained, almost to annihilate the second image and divert it so much that by proper screening it cannot be seen. It is preferable to grind the four long side faces dull, and cover them with black paint, to prevent reflection.

This prism E', is fastened to an index *a*, figs. 6, 7, so that both may be turned round their axis right or left, while the disk D, remains fixed. The latter is furnished with a graduation, the zero of which is vertically above + 180°.

2. A support F, on which a second Nichols' prism is fastened in a

case in such a way that it may be moved round its axis, and fixed accurately at any point.

3. Two shorter supports, G, G, with rests *d*, *d*, which may be lowered or raised for the reception of the tube H, lined on the inside with black velvet.

4. A stand G', which supports a small argand lamp I, of the usual construction, with a wick ½ inch in diameter. In the tube H, strong glass tubes (K, figs. 2 and 3,) of about 7 to 8 Mm. in width are placed, which have an exact length of 234 Mm. This is taken as the *normal length* in all experiments. The tubes are closed above and below by glass plates *b*, the brass caps C', C'', being screwed on, which are furnished with corks that press on the glass plates.

Fig. 6 shows the front view, and fig. 7 the side view of the graduated disk D.

Mode of Using the Apparatus.—1. *Fixing the Zero.*—When a ray of light passes through a Nichols' prism, and is observed through a second one, similar to it, two points will be observed by turning one of them on its axis, in which the polarized light disappears totally. If the first point be called zero, the other lies 180° distant from it, or is diametrically opposite to it. For our purpose it is sufficient to determine one of them.

The foremost prism E', is for this purpose fixed, by means of its index *a*, by the aid of a magnifyer, exactly on zero of the circle (fig. 6,) and then the prism E'', is turned until a transmitted ray of light disappears perfectly. This operation can only be performed with accuracy by the direct rays of the sun. For as the slightest deviation from the plane of polarization, in which all light disappears, immediately causes a small portion of it to pass through; this is so obvious by the intense light of the sun that the really dark point is confined within the smallest limits, and its determination becomes as accurate as possible. By the use of any other source of light, the determination of this point becomes so uncertain that all experiments, solely from this one cause, lose all accuracy. The prism E'', is then fixed immovably by the screw.

As the determination of the zero is only done on special occasions, and afterwards only for control, every possible care should be bestowed on it.

2. *Arrangement of Solutions.*—These are always to be prepared as colorless and clear as possible, and too much care cannot be bestowed on this point. For although slightly colored solutions may still be examined with some degree of certainty, turbid ones prevent any determination. In most cases coarsely powdered animal charcoal, previously freed from all soluble salt, is sufficient for decolorization. Long glass cylinders of different width, may be employed, furnished at the bottom with a small hole which may easily be filled up by filtering paper. These are filled ¾ with the animal charcoal, and the solution passed through by displacement, keeping the upper part filled during the whole time.

The specific gravity is then ascertained with accuracy at least within a thousandth part. For this purpose I employ, as the tubes only

hold 9 to 12 cub. cent. small hydrometers 130 Mm. long, which have the convenience of allowing small quantities to be experimented with. After the lower glass plate has been fixed firmly by the screws at C″, fig. 3, the tube is filled so that the top surface of the liquid shows a convex surface at *m*, after which the upper glass plate is put on so as to leave no air in the tube. The cap C′, with the cork, is then screwed on, and the outside of the plate cleaned as wellas possible. The tube is placed in the hollow cylinder H, fig. 1, and supported on the rests *d*, *d*, in such a way that the cap C′, reaches into the central perforation of the support K, so as to lay close to the prism E′. The rests *d*, *d*, are adjusted so as to make the axes of the prisms and the tube coincide. The prolongation of this axis must strike the most luminous part of the flame of the lamp I, which may likewise be lowered or raised on the upright G′.

3. *Mode of Observing.*—As above mentioned the instrument is fixed at zero. If then the flame of the lamp be viewed through the prism E′, darkness will be observed, if the colorless liquid produce no circular polarization, as is the case with pure water. If the contrary be the case, the flame is seen clear and with its own color.

The foremost prism, E′, is then turned to the right. If colors appear in the following order, light blue, dark blue, violet, purple, red, and orange, *then the polarization is to the right;* if the above order of colors appear on turning E′, to the left, the polarization *is to the left.* As soon as the *red* appears, which lies between purple and orange, the degrees from zero are read off as indicated by the index.

In order to determine this important point accurately by comparison, a closed tube has been fixed at M, fig. 6, which is likewise directed towards the flame. This tube is filled with a liquid which invariably by the influence of light and heat, shows exactly the same tone of red color, which is here desired. It was not an easy matter to obtain such a liquid, until Marchand found that an aqueous solution of anilate of iron answers perfectly for this purpose. It only requires a little practice to bring the desired color to correspond to the permanent color of the solution. I shall afterwards return to the particulars of this operation, when on the technical use of the apparatus.

Reasons for the Adopted Construction of the Apparatus—It is not required, with the acknowledged advantages of the Nichols' prism, to give the reasons why this prism was employed for polarization instead of the mirror in the apparatus described by Boit. By almost getting rid of the one image and attaining a greater light, the observations may be performed more easily and with greater certainty, more especially, it becomes possible to determine the zero with very great accuracy, on account of the greater light. The zero once fixed by the direct rays of the sun, it requires no change of the different parts, if the tube be placed as done by Biot, free between the prisms, and not as has been tried by securing two prisms immediately on the tubes. By the latter arrangement it becomes necessary to take apart the whole apparatus for every filling of the tube; and the zero must then be fixed by marks on the apparatus. But that this is less accurate,

may be judged of by the fact, that a difference in the adjustment of no more than one-tenth of a degree, produces a difference of nearly one per cent. in the determination of cane sugar in mixtures with molasses sugar; and this is the most frequent use of the apparatus for technical purposes, whereas the tenth part of a degree in so small a circle as that of the encasement of a prism, does not amount to more than one hundredth of a line. The simplicity in the construction where the prisms are screwed on, is more than counter-balanced by the steadiness and firmness in experimenting, whenever a number of different sugars are to be compared, and for greater certainty the experiments are to be tried several times and in quick succession. The apparently more complicated apparatus deserves, on account of its easier management, the preference.

If the sky of France according to Biot, causes great difficulties on account of the varying light, how much more must this be the case in northern latitudes! It was difficult to arrive at certain results before this difficulty had been overcome by using a good uniformly burning lamp. While clouds acted differently, from white objects on the surface of the earth, the uniform grey sky differently, from the bluish white of clear days; the effect seemed again different from places nearer the horizon, than from places of the sky which already reflected it more than usually polarised. At any rate the brilliancy of the tints differed under the above different circumstances, and this materially affects the observations. Such dependence on the time of the day, and the state of the atmosphere would be inconvenient, and in many cases, injurious.

Biot considered it easy to determine the deviation by observing the red color which follows after the purple. As we employ a solution which always shows the desired color, so that the observation does not depend on the practice and memory of the observer, the apparatus is rendered more certain and easier for many persons to use.

As the effected deviation thus becomes determinable by direct comparison, the employment of one colored light by the use of red glass is less preferable, especially as it always yields a smaller deviation, and therefore an error of observation, expressed in per centage must always be greater than by the method I employ, even independent of a greater uncertainty in the observation.

Glass tubes are preferable to metallic ones on account of the greater facility in cleaning them. The solubility of the metal is also an inconvenience, nor can reflection be altogether avoided. By proper screening, the latter may be made entirely inactive, and even without this precaution, by a proper position of the lamp it has no disturbing influence, since it returns the same colors of the centre. The use of glass plates for closing the ends has always been found useful with substances which are so easily decomposed as the sugars.

Experiments.—In the following table the sugars proper, that is, such as are capable of the vinous fermentation, either directly or indirectly, are arranged in such a manner that those which polarize most to the left are placed first, and those which produce the greatest

deviation to the right, are placed last. Then follow other substances which have some relation to the sugars and their combinations.

	Aqueous Solutions of	Degrees of Polarization. To the left.	Degrees of Polarization. To the right.	Specific gravity at 17½ C. (63½ F.)	Percent. of dissolved substance
1	Fruit sugar from grapes,	35½	—	1,1056	—
2	" " " honey,	36	—	1,1056	—
3	" " " the action of acids on cane sugar,	35½	—	1,1056	—
4	" " by fermentation from cane sugar,	36	—	1,1056	—
5	Molasses sugar,	0	0	1,105	—
6	Milk sugar,	—	43	1,102	25
7	Grape sugar, every variety,	—	46	1,095	25
8	Saccharate of chloride of sodium,	—	41	1,117	25
9	Cane sugar,	—	56	1,1056	25
10	Dextrin sugar,	—	92	1,1056	—
11	Dextrin,	—	19	1,011	3,36
12	" by calculation,	—	140	——	25
13	Mannite,	Produces no Circular Polarization.			
14	Glycyrrhizin,				
15	Glycerin,				
16	Gelatin sugar,				
17	Gum arabic,				
18	" " obtained by fermentation,				
19	Amylon in water.				
20	" dissolved by potassa,				
21	Caramel,				
22	Potassa-saccharic acid,				
23	Potassa saccharate of lime,				
24	Glucinic acid,				
25	Glucinate of lime,				
26	Apoglucinic acid,				
27	Apoglucinate of lime,				
28	Alcohol,				
29	Acetic acid,				
30	Chloride of sodium,				

Remarks on the above Experiments.

Nos. 1 to 4. Fruit Sugars.—This name has been given to a variety of sugar which under all circumstances is *uncrystallizable* and always polarizes to the left. It occurs,

1st. In a great number of sweet fruits. In this case it was prepared from perfectly ripe grapes, in which it always occurs with grape sugar. In proportion as the above sugar prevails, the grapes are sweeter, but yield less grape sugar, which agrees with experience.—

2nd. In honey, it is contained in abundance in that portion which remains liquid. It may be produced,

3rd. By the action of acids on other varieties of sugar, which are hereby not solely converted into grape sugar, but yield a mixture of both; as for instance even by the action of sulphuric acid on cane sugar in vacuo, at a temperature of from 65° to 75° C. (149° to 167°F.) whereby only a small portion of ulmic acid is formed, (Mulder) which can easily be separated. The quantity of grape sugar is often so small that its separation by crystallization requires a long time, since the presence of fruit sugar highly impedes it. The presence of grape sugar may in such cases be easily overlooked, but observe: Whenever sugars which polarize in opposite directions, occur together in such proportions that they produce no change of colors to either side, the polarizing power of the solution is still manifested by the suspension of the zero of the instrument: for it exhibits at this point, light instead of darkness. The light, which in this case when the instrument stands at zero, passes through both prisms and the solution, may still be polarized. Passed through a Nichols' prism it exhibits the phenonena of ordinary but not of circular polarization.

4th. By the influence of ferment on cane sugar and probably also on milk sugar.

Before its metamorphosis into alcohol and carbonic acid, cane sugar is converted not into grape sugar as supposed by Rose, but into fruit sugar. As soon as the fermentation is fairly under way, the solution polarizes to the left, and continues so in decreasing proportion till the sugar is entirely destroyed. By choosing the right point the fruit sugar may thus be obtained freed from an admixture of any other variety of sugar, and its perfect purification is less difficult than where it occurs together with grape sugar. These difficulties are also the cause why the results of No. 1 to 3 differ somewhat from 4.

Should it even be probable that the 4 above varieties of fruit sugar should be identical, this is yet to be proved by analysis and by their chemical combination.

No. 5. Molasses Sugar.—It is often considered a variety of cane sugar, and as such, called uncrystallizable cane sugar, sometimes it is called mucilaginous sugar, and Berzelius calls it Caramel. It is doubtful whether any one has yet fixed the true characters of this variety of sugar, in its pure state, for the different accounts of its properties disagree considerably. It is sometimes confounded with fruit sugar.

Biot and Andere prescribe for the separation of this sugar from cane sugar, wherever they occur together, to extract the mixture with alcohol. All my own experiments to arrive by this method to a certain result, failed. Molasses from cane sugar dried as far as possible, yielded to absolute alcohol even by a temperature of 50° C. (122° F.) hardly any traces of it, and with decided admixtures of cane sugar.

By the use of alcohol of specific gravity 0·812 to 0·840, and still weaker, it gave mixtures in various proportions.

The preparation of a pure molasses sugar being of the utmost importance, in order to try the application of circular polarization in practice, the effect of boiling in converting solutions of cane sugar into mo-

lasses sugar was tried. Molasses from which sugar boilers could obtain no crystals of cane sugar, and which when of a spec. grav. of 1.1056, polarized 24° to the right, was kept boiling with free access of air, and renewal of the evaporating water. With the same density it polarized

After 5½ hours boil 21° to the right.
" 11½ " " 10½° " "
" 18 " " 4½° " "
" 25 " " 0° " "

The point of ebullition was kept constant at 105–106C. (221°–222.8 F.) Kept boiling for 10 hours more it still exhibited no sign of polarization.

It seems impossible to discover by any chemical test when the conversion into molasses sugar is finished. This can only be done by circular polarization. The test with oxide of copper shows with mixtures of molasses sugar and cane sugar, in which the former amounts to 60 per cent. or more, no indication of cane sugar, for even by perfect decolorization the liquid above the precipitate of hydrated protoxide of copper shows no blue color.

Cotemporaneously with the molasses sugar, other coloring matters are formed which deserve a closer investigation. These substances are perhaps identical with those, which, according to Mulder, are formed by the action of acids on cane sugar, and which have been examined as shown in the table. Peligot's caramel is only formed by the action of heat on the sugar, where it has become dry. Its existence amongst the products of boiling is therefore incidental and may be easily avoided.

Biot observes, that as the uncrystallizable cane sugar has a smaller power of circular polarization than the crystallizable, it requires a larger quantity in order to produce the same degree of deviation when it forms a certain proportion of the mass. From this remark, it is evident that Biot did not by extraction with alcohol obtain pure molasses sugar, for the latter shows no circular polarization whatever. It is perfectly indifferent by the use of the rays of the sun, or of the flame of a lamp, or by white clouds.

Molasses sugar is likewise formed by a peculiar variety of viscous fermentation.

No. 6. Sugar of Milk.—Its composition being,

$$C_5\ H_4\ C_4 + 1 \text{ aq.}$$

which latter escapes by heat, as water of crystallization; 25 parts of crystallized milk sugar, and 75 parts of water contain then,

Milk sugar	($C_5\ H_4\ O_4$,)		22 per cent.
Water,	-	(H O)	78
			100

Cane sugar containing basic water, but no water of crystallization, its comparison with milk sugar minus 1 aq. must stand as follows:

Solution of cane sugar cont. 22 per cent. indicates	49°
" Milk Sugar minus 1 aq.	43°
Milk sugar less than cane sugar,	6°

but solutions of 25 per cent. crystallized milk sugar compared with solutions of the same per centage of cane sugar yield : 56 — 43 = 13° less for milk sugar.

No. 7 and 8. Grape Sugar comprises:

1. Diabetic Sugar.
2. Solid sugar of honey.
3. Sugar formed by the action of diastase or acids on amylon and similar substances.
4. Sugar produced by the action of many acids on cane sugar.
5. That variety of sugar which is contained in many sweet fruits, which in its pure state and freed from the uncrystallizable variety of sugar which accompanies it, (vide No. 1–3) exhibits the same peculiar form in the grouping of crystals and the same circular polarization.

Grape sugar is capable of direct fermentation, as shown by H. Rose. The whole mass does not first pass into fruit sugar, for by examination of the fermenting liquid it polarizes all the time to the right in proportion to its content, and yields at any time grape sugar in crystals. In these experiments sugar from starch was employed, obtained by the action of sulphuric acid on potato starch. Its fermentation was very vigorous.

Grape sugar loses 2 at. of water by cautious heating beyond its point of fusion. It thereby assumes the appearance of dextrin sugar, but dissolved in water its power of polarization is exactly the same as before the expulsion of its water of crystallization at the same density of the solution, and it yields likewise by crystallization unaltered grape sugar. This water being therefore only water of crystallization a solution of 25 parts of grape sugar in 75 parts of water of 1.095 specific gravity, contains

$$\begin{aligned} C_{12}\ H_{12}\ O_{12} &= 22.75 \text{ per cent.} \\ H\,O \quad &= \ \ 77.25 \quad " \quad " \\ &\overline{\quad 100. \quad} \end{aligned}$$

A solution of this strength polarizes 46.00° to the right.
" cane sugar of 22.75 per cent polarizes 50.70° " "
Cane sugar more than grape sugar, 4.70°

Compared with a solution of cane sugar of 25 per cent., a 25 per cent. solution of grape sugar ($C_{12}\ H_{14}\ O_{14}$) polarizes 10° less to the right.

Grape sugar minus 2 at. of water of crystallization indicates therefore very nearly the same deviation as cane sugar.

No. 8. Exhibits the circular polarization of the compound of grape sugar with chloride of sodium. According to Erdman and Lehman. the formula for this compound dried at 130° C. (266° F.) is, in 100,

$C_{24}\ H_{24}\ O_{24}$	=	82.46
Na Cl	=	13.42
2 aq.	=	4.12

25 parts dissolved in 75 parts of water contain therefore in 100 parts

20.62	$C_{12}\ H_{12}\ O_{12}$	
3.35	Na Cl	} = 79.38 non-polarizing substances.
76.03	Water	

But 20.62 per cent. of grape sugar freed from its water of crystallization and dissolved in 79.38 water, yields likewise 41° deviation as shown in the table. The polarization agrees therefore exactly with its chemical analysis and renders it so much the more probable that the grape sugar enters unchanged into this remarkable combination.

In some cases of diabetes when urine contains sugar, so as to be capable of fermentation, it sometimes polarizes to the left, so that it must contain either a substance which polarizes to the left, or what is not improbable actual fruit sugar.

Biot assumes that uncrystallizable grape sugar, as he calls it, passes by crystallization into a sugar analogous to starch sugar, which then, under any circumstances, polarizes to the right. But this seems to be a deception. It has been already mentioned that fruit sugar (which is Biot's uncrystallizable grape sugar,) impedes in a high degree the crystallization of grape sugar, which often accompanies it. The mixture therefore remains liquid for a long time, but at last crystallization takes place, especially at a low temperature and the proper degree of concentration. The grouping of the minute crystals of grape sugar then often renders the mass so porous that it absorbs the fruit sugar and becomes solid. One part of fruit sugar with 9 parts grape sugar, give a solid and apparently a dry mixture, in which the fruit sugar may be easily overlooked.

No. 9. Cane Sugar.—The density with 25 per cent. of pure sugar corresponds exactly with Niemann's table, which is very correct.—In future the specific gravity of 1.1056 will be called the normal density whenever the question is to determine the per centage of crystallizable sugar in sugar of cane.

No. 10. Dextrin Sugar.—When *amylon* is converted into grape sugar either by dextrin or by acids, a sugar is formed which remains uncrystallizable under all circumstances, and appears to be as it were a medium substance between both. Commercial starch-molasses, as it is called, when properly prepared and freed from coloring matters, consists mostly of this variety of sugar which may be called dextrin sugar. Its crystallization which the manufacturers are so much afraid of, only occurs when it is mixed with too much grape sugar.

Biot mentions that he has found several varieties of sugar obtained by the action of sulphuric acid and oxalic acid on amylon, to exhibit a stronger polarization. "It would be important, says he, to investigate whether these varieties of starch sugar with very strong polarization power be not mixtures or combinations of dextrin with starch sugar." This investigation seemed much facilitated since the discovery of Trommer, that dextrin mixed with a solution of sulphate of copper, yields by the addition of a dilute solution of caustic potassa in excess a solution of an azure blue color which does not change. Grape sugar yields, it is true, a similar solution, but only for a few moments. The solution soon becomes turbid and changes into green, then yellow, and deposites hydrated protoxide of copper. Fruit sugar, molasses sugar, mannite, and milk sugar, exhibit the same reaction. Cane sugar yields a similar blue solution as dextrin. As starch is not converted into cane sugar, it was to be hoped that by this beauti-

ful test (the copper test) the presence of dextrin might be discovered in starch molasses. A solution of 3 parts of starch sugar and 2 of dextrin was tested in this way, but after some time it only exhibited in the cold the test of pure starch sugar. By heating to about 40° C. (104° F.) it took place at once; the supernatant fluid was never of a blue color, nor was this the case with starch molasses alone. Fermentation was then tried when it was found that after the destruction of the sugar, a considerable quantity of dextrin remained, which by repeated treatment with alcohol could be obtained as pure as that obtained by nitric acid and amylon.

Alcohol in sufficient quantity, extracts dextrin sugar and grape sugar which always occurs in commercial starch molasses. After separation of the latter, the dextrin sugar remains, being completely destructible by fermentation. It shows in this case the strong polarization to the right, indicated in the table.

Solutions of grape sugar and dextrin sugar (containing say 40 per cent. of the latter) crystallize soon in cold, which proves that the crystallization of grape sugar in starch molasses must be prevented by something else, which is the dextrin sugar acting here as fruit sugar, and in combination with the dextrin prevents the crystallization for a long time.

No. 11 and 12. Dextrin.—The very great deviation caused by this substance, amounts by calculation for a solution of 25 per cent., to over 140° to the right.

No. 13. Mannite. Both that from manna, and from celery (apium graveolens) behave as stated.

No. 14. Glycyrrhizin.—Its deep color allows only the employment of a very dilute solution.

No. 15. Glycerin prepared from linseed oil.

No. 16. Gelatin Sugar free from leucin, as described by Mulder.

No. 17. Gum.—According to its behaviour it was the genuine gum arabic.

No. 18. Solutions of cane sugar of 1.050 spec. grav. pass by the action of a peculiar ferment at the ordinary temperature of the air under certain circumstances, very rapidly into a kind of viscous fermentation, so that the whole mass may be drawn into long threads. No generation of gaseous products is observed. The cane sugar soon disappears while a gum-like mucus, molasses sugar and a small quantity of an acid (perhaps lactic acid) are the products; afterwards very different decompositions take place. This mucus yields by the copper test, a blue solution like dextrin, but differs from it both in its want of polarizing power, and in other points.

No. 19 and 20. Amylon either dissolved in boiling water and filtered, or in cold water by the addition of some caustic potassa.

No. 21. Caramel prepared according to Péligot. Its dark color allows the employment of only very dilute solutions.

No. 22 and 23. Potassa—saccharic acid and its lime salt prepared according to Péligot.

Nos. 24 to 27. Glucinic and Apoglucinic acids and their *combi-*

nations with lime (sacchulmic acid and sacchulmine) obtained by the action of sulphuric acid on cane sugar according to Mulder.

The sugars proper, considered without regard to their chemical behaviour may be found to agree in the following properties: 1. They are without color. 2. They possess a sweet taste differing in intensity. Their solutions of the same specific gravity would form a series as follows: Cane sugar, sugar of fruits, molasses sugar, dextrin sugar, milk sugar, grape sugar, being the least sweet. 3. They are fermentable: Fruit, molasses, grape, and dextrin sugar directly, milk and cane sugar indirectly.

It may also be remarked that all sugars proper may by any reaction, be converted at last into grape sugar, but that the latter is incapable of being converted into any other variety of sugar.

To be Continued.

On some Remarkable Properties of Water and other Fluids, and their Connexion with Steam Boiler Explosions. By John Enpowes Bowman, Esq.

(Continued from page 188.)

The lecturer proceeded to draw from his enquiry, something of a practical, and therefore perhaps more interesting character, with reference especially to the subject of steam-boiler explosions; a subject on many accounts of so much importance, that no words of his were needed to enlist attention for a short time to it.

Until within the last few days, he had supposed that no one had attempted, previously to M. Boutigny, to account for the explosion of boilers on the supposition that the water in them passes, under certain circumstances, into the spheroidal state. In this, however, he found that he was partially mistaken, and felt great pleasure in saying, that one of his townsmen, Mr. Robert Armstrong, some few years ago, advanced an idea on this subject, a good deal similar to that of M. Boutigny. If heat be applied to water contained in an open boiler, the temperature of the water will of course continue to rise until it reaches 212°, when the elastic force of the steam is sufficiently great to overcome the pressure of the atmosphere, and the water boils. If the heat be still continued, the whole of the water will boil away, leaving the vessel empty; but as long as any liquid remains, the temperature of the vessel never rises above 212°, owing to the absorption of heat by the steam. As soon as the boiler, however, is empty, its temperature of course rapidly rises, and may reach a red, or even white heat, provided the furnace be sufficiently powerful. If water be now gradually thrown into the over-heated boiler, we know from what has already been said, that it will pass at once into the spheroidal state, and will continue at 205°, until, from some cause or other, it is permitted to *come in contact* with the heated surface, when violent ebullition immediately takes place, an enormous quantity of steam is instantaneously produced, and if the vessel be a closed one, as is the case with steam-boilers, an explosion is the almost inevitable result. An experiment exceedingly easy of performance, is sufficient to

illustrate this. Let a large spheroid be formed in a vessel of platinum or copper; so long as the heat is applied to the latter the water never shows the least sign of boiling; but if the lamp be extinguished, and the vessel allowed to cool a little, the water suddenly comes in contact with the metal, an enormous quantity of steam is instantly formed. A spheroid composed of between four and five pints of water has been, in this way, experimented with, when the sudden formation of highly elastic steam was very striking. If water be boiled for some time in a copper flask, or small boiler, until the whole of the air is expelled, and the vessel be then tightly corked, and the source of heat removed, it is well known that as the water cools and the vapor condenses, a partial vacuum is formed; and, owing to the external pressure of the atmosphere, the cork is held firmly in its place, and offers considerable resistance to any attempt to withdraw it. Far different, however, is the effect produced, if, instead of boiling the water in a comparatively *cool* flask, it be thrown into one which is sufficiently hot to cause it to pass into the spheroidal state. So long as the flask continues hot, nothing remarkable occurs; but if the lamp be removed and the temperature of the metal be allowed to fall lower than 350° or 400°, a faint noise is shortly heard, and the moment after, a violent explosion takes place, projecting the cork or stopper from the mouth with considerable force.

Now, all this is easily explained. The water, on ceasing to be spheroidal, *wets*, or comes in contact with the heated boiler, and is converted instantaneously into steam, which, being thus generated in vast quantity, finds an outlet at the point of least resistance. This experiment proves that if water exists in the spheroidal state in a boiler, and the boiler be allowed to cool, owing to the extinction of the fire, an *explosion* is the almost certain consequence. A result precisely similar is produced by adding a quantity of cold water to a boiler containing a portion of liquid in the spheroidal form. But here the question arises, Does water really ever become spheroidal in steam boilers? and if it does, what are the circumstances which lead to so dangerous a crisis? That water contained in boilers does pass into the spheroidal state, there can be no doubt, since we know that sometimes circumstances are such that it could not possibly be otherwise, and moreover, it has actually been seen to be so. What then are the causes which lead to this occurrence? The most obvious cause is a deficiency of water in the boiler; owing either to the negligence of the engine man, or to some defect or derangement of the feed-pipe. When this deficiency occurs, the boiler, if the furnace underneath be in action, shortly becomes highly heated, and it is by no means an uncommon occurrence for it to reach even a red heat. If water, under these circumstances, be thrown in, the first portion becomes, of course, spheroidal, and continues so, until, by the addition of a larger quantity, the boiler be so far cooled, as to be unable to maintain the spheroidal form of the water; no sooner is this the case than the spheroid comes into contact suddenly with the overheated boiler, bursts into steam, and in all probability, an explosion is the result. Another and highly probable cause of water becoming spheroidal is suggested

by Mr. Armstrong, in his excellent work on Steam-engine Boilers, and which is well worthy of notice. After alluding to the subject of boiler incrustations, and the effect they have in preventing the passage of heat from the furnace to the water, owing to their non-conducting property, he says:—

"Under similar circumstances to those mentioned, there can be no doubt that a part of the boiler occasionally becomes nearly red-hot, although this condition appears extremely inconsistent with the supposition, that it is at the same time covered with water; yet we have been compelled to adopt this conclusion, from having had ocular demonstration of its possibility, as well as other reasons. We had frequently heard the fact stated by intelligent engine men, and had been called, more than once, to witness it, although even then inclined to consider it a mistake, owing to the difficulty of ascertaining it clearly; for a slight approach to the incandescent state must be nearly invisible, owing to the strong glare of light from the furnace directly beneath, while any degree of heat much higher, would be sure to weaken the iron so much as to cause the boiler-bottom to give way. The probability of boilers sometimes approaching a red heat, receives a corroborative proof on examination of the iron plates, in cases when the boilers have bulged out, and which exhibit an appearance well-known to boiler-makers by a peculiar color in the iron surrounding the part which has been red-hot.

"Whenever," he continues, "a boiler is seen in this state, of course the only method of avoiding danger is to slack the fire immediately by opening the fire doors. But it frequently happens that the fireman thinks that the boiler is empty, and if he has an opportunity, he immediately lets into it a quantity of water, when the *consequence uniformly is, that the boiler bursts instantly.*"

The bursting in this case we can now readily understand. It is precisely similar to our last experiment, in which the spheroidal state of the water was destroyed by the addition of a quantity of cold water.

Mr. Armstrong goes on to say,—"From what we have stated above as the common practice in some districts, we may conclude that the principal cause of boilers becoming unduly heated, is undoubtedly, in a majority of cases, owing to the interposition of indurated or encrusted matter between the heated *iron and the water*, and the manner in which those circumstances operate in producing an explosion, appears to be as follows:—

We have before shown that an internal coating of boiler scale is liable to break and separate into large pieces, which are thrown off from the boiler with a certain degree of violence, at some particular degree of temperature, depending upon the thickness of the scale, and the kind of substance of which it is formed." He then proceeds to explain how, by the sudden separation of those pieces of encrusted earthy matter, the water flows upon the overheated metal, when, of course, the result will be, that a portion of the water becomes spheroidal, which, on subsequently coming in contact with the hot surface, is immediately converted into steam. Seeing then, the imminent danger which always attends the presence of the spheroidal water in a

boiler, it becomes a question of the highest importance, whether any means can be devised, which will effectually prevent such an occurrence.

If it were possible to ensure a constant, uniform, and never-failing supply of water to the boiler on the one hand, and to prevent the accumulation of earthy sediment or crust, on the other, there would be little or no fear of the water ever becoming spheroidal. But there are great and serious obstacles in the way of these conditions being practically complied with; both on account of the liability to derangement which affects most kinds of feeding apparatus, and the great difficulty which exists, both in preventing and removing the depositions of the earthy matters which are found more or less abundantly in most kinds of natural water.*

It has been found that the more smooth and even the surface of a metal is, the more prone is water or any other liquid, on being thrown upon it, to pass into the spheroidal state; and that any great roughness, or especially the presence of sharp points considerably lessens the danger of such a change. There is, however, a great objection to fixing projecting points in a steam-engine boiler, on account of the difficulty they would occasion in cleaning it out; and the idea occurred to M. Boutigny of placing in the boiler, loose pointed pieces of iron, of such a shape, that one of the points should always be uppermost.

Before concluding, he would say one word respecting the possibility of preventing an explosion, even when the water *has* become spheroidal in a steam boiler.

And here an experiment, which we have already seen, will suggest the best mode of proceeding, in order to avert the impending danger. When water was thrown into a hot platinum crucible, and thus made to assume the spheroidal form, we found that so long as the crucible continued hot, the globule floated on its bed of vapour, slowly and gradually evaporating, and showing no appearance even of boiling, still less of passing explosively into steam; but no sooner did we allow the crucible to cool down to a certain temperature, than the water, on touching its still overheated sides, was instantly dissipated in the form of highly elastic steam.

If then, it be ascertained by the engine man, that the water in a boiler has become spheroidal, his chief care should be to keep up the fire, and also to prevent most completely the influx and further supply of water; since non-compliance with either of these conditions, would cause the cooling of the boiler when the spheroid would, in all probability, shortly be converted suddenly into steam, and an explosion would be the almost inevitable consequence. But if, on the other hand, that spheroid be *not* allowed to touch the boiler, it will calmly and slowly evaporate, without occasioning any further inconvenience than rendering the engine comparatively inactive, until it has returned to the natural condition.

* As most kinds of spring and river water contain, in solution, some earthy matters which are left by the evaporation of the water, giving rise to the formation of sediments and incrustations, it had often occurred to the lecturer, that rain-water might be substituted with great advantage.

The advice then, relative to this subject, which should be given to those who have the charge of engines is simply this:—

1*st*. Be careful that the boiler is kept as free as possible from earthy incrustations, which, if allowed to accumulate, form, in fact, a boiler of stone inside the iron one, and thus retard the passage of heat from the fire to the water, until the iron has become more or less overheated.

2*ndly*. Never let there be a deficiency of water in the boiler, since, when that happens, the latter may become heated almost indefinitely, and is consequently sure to render the water spheroidal, when thrown in; when an explosion will be (without great care) almost certain.

And, lastly, if it be known that, owing to any cause, the water in a boiler has already become spheroidal, instantly stop the supply of water, and take care that the fire is well kept up, until the whole of the water is evaporated; when that is the case, the boiler should be allowed to cool to its natural temperature, when water may be added, and the fire rekindled.

[At the conclusion of the lecture, an extremely interesting discussion took place, in which the chairman and several other scientific men took part, in the course of which, the case of the late explosion of a locomotive engine on the Manchester and Leeds railway was considered; but all agreed that its origin could not be attributed to the formation of spheroids in the boiler, as it had at the time of the explosion, abundance of water in it, neither was it at all encrusted by any earthy matter. All the circumstances of the case being considered, it would appear that the only tenable supposition which could be entertained as to its origin, is that of simple over pressure. The steam having burst the top of the inside fire-box, and come in contact with the ground beneath, the re-action thereby occasioned, was considered sufficient to raise the engine to the height mentioned, namely, thirty feet.

Nevertheless we could enumerate many instances of explosion, which might with perfect justice be attributed to the formation of spheroids on the water getting low in the boiler; perhaps we may cite the case of the Telegraph steamer, which exploded at the Helensburgh quay, in March, 1842, as being the most likely one of any we can at present remember. An account of this explosion will be found in our first volume, at page 274. The engine, in this instance, had made one stroke, and was in the act of making a second, when, for a moment, a hissing noise was heard; this was followed almost immediately by a terrific explosion.

The supposition in this case would be, that the water in the boiler having become low during the standing of the engine, it had assumed the spheroidal form, and immediately upon the starting of the engine, the influx of water from the pumps (if in action at the time,) would reduce the heat of the boiler so far, as to render it unable to maintain the spheroidal form of the water. No sooner was this the case, than the spheroids would suddenly come in contact with the heated metal, and explosion would immediately ensue.

This subject, however, is one which certainly merits further inves-

tigation, and we are persuaded that a more strict inquiry into it, would throw a good deal of light upon various serious explosions, which, until now, it was impossible to account for.]

Glasgow Prac. Mec. and Eng. Mag.

Stephenson's Railway Wheel.

This is one of those practically good improvements, which we should like to see more generally imitated by the engineering profession, as it combines extraordinary cheapness with great durability and elegance of appearance. It is the production of Messrs. R. Stephenson & Co., at their locomotive factory, where several thousands of the wheels have been manufactured within the last two or three years, being, in fact, the staple wheel of that celebrated firm.

Fig 8. Plate 1, is an elevation of a four feet locomotive wheel, with tyre complete, made on this principle.

Fig. 9, is a section through the centre of the wheel.

Fig. 10, is a view of one of the pieces of rolled T iron, bent into the shape required for the spokes.

A, Fig. 10, is a cross-section through one of the spokes, and

Figs. 11 and 12, are side and front views of the cast-iron block used for bending the spokes to their shape.

The peculiarity of the improvement consists in forming the spokes of the wheel of rolled T iron, of the section shown at A, Fig 10.

In making the spokes, the length required for each is first accurately measured off, and centred longitudinally, the projecting fin is then slightly bevelled off at each extremity as shown at *a*, Fig. 10; a hole is now punched through it at the same part, and it is then ready for bending.

For this purpose the block (Figs. 11 and 12) is used, it is grooved down the centre for the purpose of receiving the projecting fin of the bar. The length of iron before mentioned is now made hot and bent round the block, the central notch being applied to the central point of the block, so that the bends are made exactly in the centre, the block is slightly bevelled inwards at the point on each side, so as to give the ends of the spokes a better hold in the boss, and is in two halves, divided down the central groove, for the purpose of allowing the detachment of the spokes when bent; the two halves are held together whilst in operation by a powerful screw passing through the centre of each half.

Each spoke, or rather each pair of half spokes (for it will be seen by reference to A, that each spoke is formed out of two bent pieces) is now laid on a plate, and the boss cast on in the usual manner, the holes in the ends of the spokes being of material use in giving them a firm hold in the boss. The tyre is now shrunk on in the usual manner and the vacant spaces at the parting of the spokes where they meet the inner side of the tyre, are filled up with baked oak timber which is secured by driving into it two small iron wedges.—These pieces of wood are found to answer as excellent preventives of

vibration in the wheel; and being wedged up in a very dry state, they are afterwards swelled by the moisture of the atmosphere, so that no joint whatever is seen, the whole having the appearance of solid metal.

It will be seen that the projecting fin on the spoke-iron is not in the centre of the metal; this is to allow of the insertion on the wider side of a ¾ inch bolt, for securing the rim portion of the spokes of the wheel to the tyre; a bolt is placed in the centre between each spoke, and being on the inner side, as shown in the section, they are not at all seen from the outside. If the size of the wheels is more than 5 ft. or 5 ft. 6 inches, a single rivet is put in each spoke to connect the two halves more firmly, but in small wheels this is not at all required, the contraction of the tyre produces so close a contact between them that the joint is scarcely perceptible. The general practice has been to put an equal number of spokes in these wheels, as in the example here given; we think however, that a decided improvement might be effected, by using an odd number, so that no two opposite spokes would be in one diameter allowing thereby a certain degree of elasticity in the wheel, which, we think, would be favorable for both the wheels and the rails. It has been found in practice that these wheels are most durable when the spokes are not wider apart than 12 inches measured on the rim, also the smaller the radius of curvature of the spokes at the parting the better; in the present instance, it is about two inches.

No small argument in favor of these wheels is their elegant general appearance, due to the shape of the spoke. With regard to their durability, we understand that of several thousands, which have been running for some time upon various lines of railway, not one has failed through any fault in the construction. Their very great cheapness, likewise, compared with wheels made in the usual manner with round or flat spokes, is another point in their favor: being, we should suppose, as far as workmanship is concerned, not more than one-sixth.

Ibid.

The Scotch Pig-Iron Trade.

The manufacture of pig-iron in Scotland is steadily on the increase. In the *Mining Journal* of the 7th inst. we gave a tabular statement of the number of furnaces in existence and in operation, from which it will be seen that, up to the end of May, the total number of furnaces in Scotland was ninety-one, of which seventy-five were in and sixteen out of blast. We now find, from the following table, that up to the end of June there are ninety-one built, twelve building, and ninety in blast, being an enormous increase in so short a time, and fully proves that there exist capabilities for increasing the make of iron in proportion to the demand, to an extent which some of our contemporaries have deemed impossible. We have seen it asserted, that "not another furnace could be blown in within twelve months;" yet here we have an additional number at work, capable of producing several hundred tons of pig-iron per week. That an enormous and

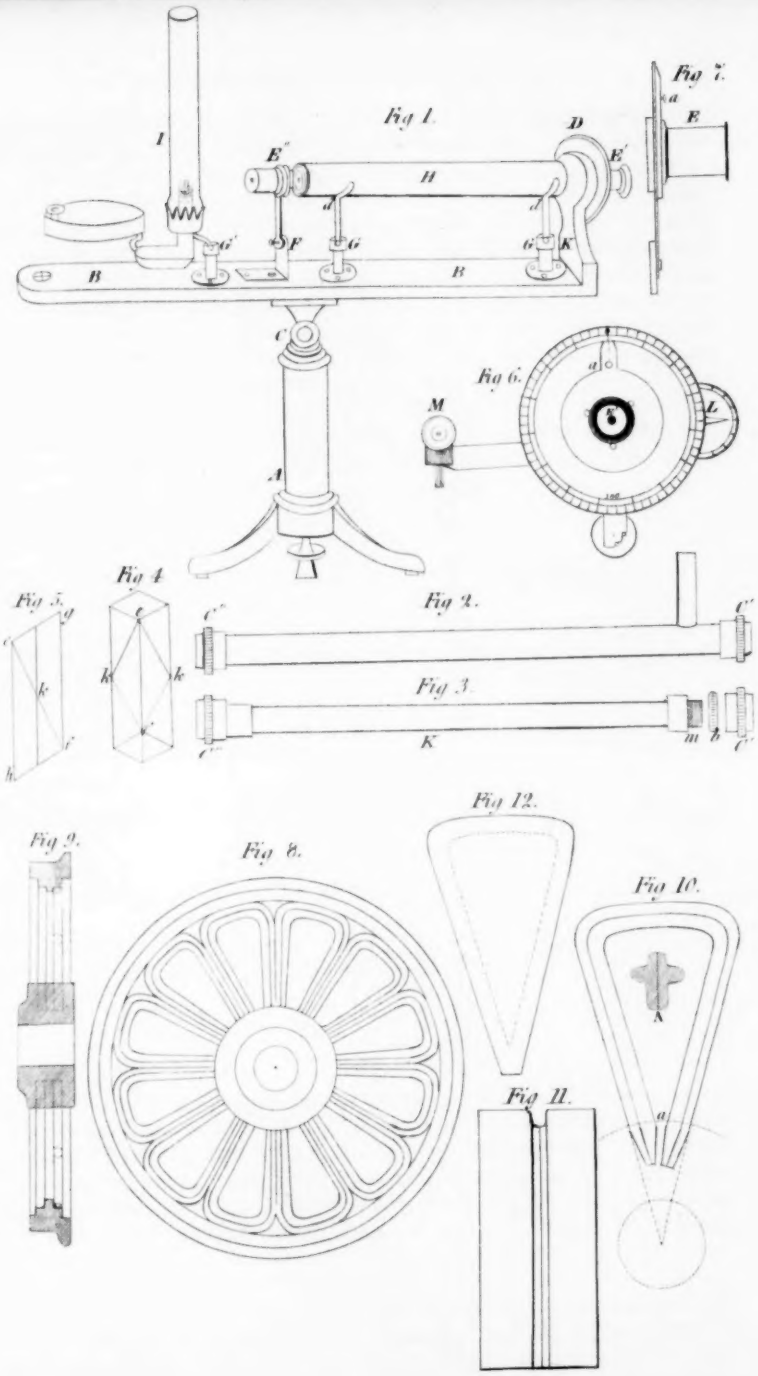
Fig 1.
Fig 7.
Fig 6.
Fig 4
Fig 5.
Fig 2.
Fig 3.
Fig 12.
Fig 9.
Fig 8.
Fig 10.
Fig 11.

continually-increasing demand for iron, for all the great engineering works proposed, must take place there is no doubt, but we do think that it will be found that there is capital and enterprise among the iron masters equal to the emergency; it is the system of speculating on the demand, buying for the account, and not the demand itself, which has caused so much of the unpleasant consequences which have, of late years, at intervals marked the iron trade; were all transactions *bonâ fide* sales, and would the smaller makers abandon the often ruinous practice of taking large orders, which it is not in their power to execute, the iron trade would be as steady as any branch of commercial business—paying a good per centage for the capital invested, and supporting a very large amount of the working population in comfort. The following is a statement of the blast furnaces, and weekly produce of pig-iron in Scotland, in June, 1845:

	Building.	Built.	In Blast.	Weekly Produce.
Gartsherrie,	–	16	15	1700
Dundyvan,	–	9	9	1000
Monkland,	2	7	7	850
Calder,	–	8	6	660
Govan,	–	5	5	650
Langloan,	1	5	5	650
Carnbroe,	–	6	5	560
Clyde,	–	6	5	540
Coltness,	1	5	5	600
Summerlee,	–	5	4	420
Glengarnock,	1	4	4	520
Shotts,	1	3	3	300
Muirkirk,	1	3	3	250
Carron,	–	3	3	240
Devon,	–	3	2	160
Blair,	4	3	3	330
Castlehill,	–	2	2	200
Omoa,	1	3	2	180
Garscube,	–	2	1	100
Bonaw,	–	1	1	50
	12	99	90	9960

The stocks of pig-iron in Glasgow have, in fact, increased to an enormous amount, causing many to believe that the supply has outstripped the demand, but which, we believe, to be only the effect of the ironmasters speculating for a rise, and when such a situation of things becomes general, however the price might for a time be bolstered up, the "crash" must come at last. To attain permanent prosperity in so extensive a branch of industry as the iron trade, the supply should go to a certain extent hand in hand with the demand; and now that German, French, and American capitalists are successfully improving their make, and competing with us, it is time that English and Scotch iron manufacturers should take measures to secure those markets, which, by careless, and even reckless speculation, may be lost to them for ever. **Mining Journal.**

Jeffery's Marine Glue.

The government of France having had their attention immediately directed to the importance of the patent marine glue, which, from its great strength and preservative qualities, has given such universal satisfaction, a commission was appointed by the Minister, in November, 1843, to make a series of experiments at the port of Toulon, directed to the making top-masts in separate pieces, the preservation of timber under water, and bottoms of ships, the caulking of vessels, putting together blocks of stone and cementing masonry, and also its application to the preservation of iron plates and chains, having specially in view the bottoms of iron vessels, and to report thereon; only those relating to caulking ships, and the preservation of timber under water, and iron plates, are yet sufficiently matured, and on these they have made a report. The marine glue was applied to the caulking of the poops of the steamer *Le Titan*, the ship *L'Ocean*, and the frigates *L'Iphigenie* and *La Proserpine*. *Le Titan* remained exposed to the sun during the whole summer of 1844, without ever being wetted, and when the winter rains set in, not a drop of water passed through the seams; the glue still adhered, notwithstanding all the movements they had gone through from the action of the heat and humidity; with the former the seams opened, and the glue remained in them; in the latter they closed, and the glue was forced out, forming a hard beading, which it was very difficult to remove. The *Ocean* was on the Tunis station, and experienced very bad weather, she, however, returned to port in December, and her caulking remained perfectly sound. The *Iphigenie* was payed on the 2d and 6th of August, without oakum in the seams; she was at sea in very bad weather, and although her planks worked exceedingly, the caulking with the marine glue still remains entire. These instances prove that the glue perfectly resists the motions of the vessel, and adheres to the planks, even when they gape, in consequence of the laboring of the vessel. It is found superior in regard to its durability, since it is still completely unaltered on board the vessels where it had been used eight months ago, whilst the caulking with pitch required to be done over at the end of the same period. The marine glue has another important advantage over pitch, which is, that it will not melt except at a much higher temperature. It often happens in hot climates that the pitch becomes so soft as to melt through the seams, and sticks to the feet; this is an inconvenience which has not occurred with marine glue. From these experiments, the commission has agreed on the following decision:—"That the marine glue caulking is superior to common caulking for rendering the seams impervious; and its greater expense at first, in comparison with the latter, is fully compensated by its superiority and greater durability. The commission, therefore, considers that it will be for the advantage of the state, to substitute marine glue for pitch and oakum." They then proceed to experiments for the purpose of trying the effects of the marine glue as a preservative from marine insects, weeds, and shell-fish. A four-sided box was made, each side con-

taining five planks; some of these planks were coated with the glue, mixed with 2 per cent. of a poisonous mixture of bi-chloride of mercury dissolved in ligneous spirit; some only had a horizontal stripe laid on them, and some were left without the poisonous preparation; the box was immersed in a part of the wet dock at Toulon, remarkable for the vigorous attacks of marine insects, and the abundance of marine vegetation, on the 10th June, 1844, and first examined on the 9th September, when the parts unprepared showed the usual ravages of the insects, and were covered with shells and seaweed; the prepared planks showed no signs of punctures, but those parts not poisoned were covered with weeds and shells. From the foregoing experiments, it results that the poisoned marine glue preserves the wood from the punctures of marine insects; and that the corrosive sublimate dissolved in ligneous spirit and applied over the marine glue, protects, at least for a certain time, the surfaces under water from the seaweeds and shells, and that the experiments made on a boat and on the bottom of the schooner *La Topaze*, confirm the foregoing results.

Mining Jour.

Extracts from the Transactions of the Fifteenth Meeting of the British Association for the Promotion of Science.

On a New Property of Gases, by *Prof. Graham.*—After explaining the law which regulated the diffusion of gases through porous bodies, and stating the fact, that the lighter gases diffused themselves much more speedily than the more dense ones,—that their diffusion was equal to the square of their densities,—he proceeded to relate his experiments on the passage of gases into a vacuum. To this passage the term Effusion has been applied. The velocity of air being 1·, the velocity of oxygen was found to be ·9500 by experiment, and by calculation ·9487. Carbonic acid, being much heavier than air, gave the number ·812. Carburetted hydrogen gave ·1322 as the velocity of its effusion. Hydrogen gave as the velocity of effusion 3·613 by experiment, which was very nearly the amount given by theory. The interference of friction, even of minute orifices, was then described, and shown to admit of easy correction. Some useful applications were mentioned; as in the manufacture of coal gas, where it is desirable to ascertain the quality, as well as the quantity of gas manufactured. As the gas will pass the orifice on its way to a vacuum the quicker the lighter it is, and the more slowly as it increases in density, and as the superior carburetted hydrogen is heaviest, it would be easy to construct an instrument to register this velocity, and thus mark at once the required quality and quantity of gas. It was also proposed that an instrument might be used in mines to detect the presence of light carburetted hydrogen (fire damp.) The passage of gases under pressure through porous bodies was termed by Prof. Graham, Transpiration. The mode adopted in experiment, was, to take a glass receiver, open at the top, which was closed with a plate of stucco. This

was placed on an air pump, the air exhausted by the pump, and the velocity with which the air passed through the stucco being marked by the mercurial gauge of the pump. The transpiration of atmospheric air was found to be greater than that of oxygen. Carbonic acid is found to be more transpirable than oxygen—or even, under low pressure, than atmospheric air. The transpiration of hydrogen is one-third more rapid than that of oxygen. The applicability of this process of experimenting to the explanation of exosmose and endosmose action in the passage of fluids through porous bodies was pointed out.

Mr. Bain made some observations to the effect, that Prof. Graham's researches went to explain many meteorological phenomena, but particularly the suspension in the atmosphere of masses of aqueous vapor, in the form of clouds.

On Recent Experiments on the Gas Voltaic Battery, by *Prof. Grove.*—No previous description of the Gas Battery having been given before the Association, Prof. Grove entered into an explanation of the action of hydrogen gas upon spongy platina, and gave a description of the first gas battery constructed with platina wire sealed into glass tubes in pairs,—hydrogen being put into one tube, and oxygen into the other. An arrangement of this kind being connected with a voltameter, it was found that exactly the same quantity of gases was eliminated in the tubes of that instrument as combined in the tubes of the battery. Experiments have been made with a view of ascertaining if other gases might be used in the battery, and it was discovered that a great variety of gases might be so used. Prof. Grove then pointed out how perfectly any eudiometric analyses might be carried on with the gas battery, provided some attention were paid to a few sources of error. A form of the instrument as hitherto constructed by Prof. Grove was described, for the purpose of avoiding the absorption of atmospheric air by the fluid in the cells of the battery. A more recent construction of the battery was next described, in which many of the imperfections in the former instruments were removed, and a combination of several pairs of gas tubes are connected in one compact body. Another advantage arising from this battery is the really constant condition of it; once charged, it appears that the action will go on for years, requiring nothing more than occasionally, at long intervals, adding a little zinc to the acidulated solution in the cells, for the purpose of supplying the loss of hydrogen in the tubes. The results of long experiment have shown that the most invariable action may be counted on for years; and that, by this instrument, experiments requiring for a long period the constant flow of a galvanic current may be most effectually carried out. Some experiments on the combination of phosphorus and sulphur with oxygen in the battery were then named; and it was found, that any body capable of volatilization gave a galvanic action with oxygen in the other tube. Camphor, alcohol, ether, and other bodies proved the constancy of this effect. It was then stated, that in all cases it had been found that chemical action and voltaic action were convertible into each other.

On the Action of Gases on the Prismatic Spectrum, by *Dr. Miller.*—Referring, in the first instance, to the experiments of Sir D. Brewster on the changes produced on the fixed lines of the prismatic spectrum by various absorptive media, Dr. Miller proceeded to explain his method of examining the subject. The light, being passed through a longitudinal slit in a plate of metal, was received on a prism of Munic glass; the spectrum thus formed was passed through the gaseous medium under examination, and the resulting effect observed by a telescope. It was found that the dark lines of the spectrum materially changed their positions as different colorless gases were used; and that, by subjecting the spectrum to the absorptive influences of chlorine, nitrous acid vapor, the vapors of iodine, bromine, &c., numerous dark, and some luminous bands, not previously observed, were brought into view. The spectra produced by colored flames was also examined, and many curious conditions observed. Dr. Miller had sought to ascertain if any relation could be found between the chemical characters of the bodies under examination and their properties of exhibiting Fraunhofer's lines; but as yet no such relation could be detected.

Recent Experiments on Ozone, by *Prof. Schönbein.*—Professor Schönbein was first induced to undertake his researches from the obscurity which rested upon the phenomena of the odor produced during the galvanic decomposition of water, resembling the smell of an electrical machine, and during thunder storms. In pursuing these researches, the author was led to the discovery, that the smell was always developed at the positive pole; that it was capable of being preserved in closed bottles; that heat destroyed it, and that many of the metals had also the same power. Experiments were made with a view to discover some means of procuring ozone easily; and after the trial of a great many bodies, it was found that phosphorus was particularly suited for the purpose. If a piece of phosphorus is placed in a bottle of common air, when maintained in a moist state, it readily produces this peculiar principle, on which the electrical smell depends. Several experiments were shown, to illustrate the effects of ozone in bleaching litmus paper and paper colored with indigo, or a solution of that substance. If powdered iron or silver are placed in vessels containing ozone, the smell is immediately removed, and the metals exhibit a kind of oxidation. Other bodies were named, as producing a similar result; and many chemical decompositions were found to arise from exposure to the action of this peculiar principle. Solution of iodide of potassium is rapidly decomposed, iodine being set free; this was shown by a mixture of this salt with starch, which, on being exposed to the action of ozone, turned blue by the formation of iodide of starch. Bromide of potassium was also decomposed by this principle, and bromine liberated. Salts of iron were shown to undergo the same changes. A number of organic bodies, both vegetable and animal, destroy the ozonous smell. If ozonized air be made to pass through a tube, and this tube gently heated, all the properties of ozone

are destroyed. This was shown by experiment. By the inspiration of ozone, similar effects are produced on the lungs to those resulting from chlorine and bromine. A mouse was killed in five minutes, and the experimentalist himself was seriously affected by breathing an atmosphere charged with this odor. By electrolysis, gold or platina points are necessary for the development of ozone. The electrical brush in all cases produces the same effects as those above described; all the decompositions can be produced, and the same smell is distinctly evident. In this case, as in the other, heat and some of the metals also destroy the odor. Endeavors have been made to procure ozone in an isolated state, but they have not been successful. Ozone, although at first supposed to be an elementary body, was afterwards considered as a compound of oxygen and hydrogen. The fact of heat destroying this peculiar odor at once, shows that this principle is produced from the elimination of an oxygen compound from the decomposition of water. This is quite in accordance with the views entertained by Marinlac, who has pursued the investigation with great industry, and who has published a memoir, in which his views are luminously set forth. The author of this report is of opinion that ozone will turn out to be a compound isomeric with the binoxide of water. A theoretical view of the production of this body was then entered into. The ordinary action of phosphorus undergoing oxidation in the atmospheric air was explained, and the remarkable fact stated that although phosphorus was luminous in moist air, it was not so in perfectly dry air. Ozone may now, therefore, although long regarded by Prof. Schönbein as an elementary body, be looked upon as, in all probability, a tritoxide of hydrogen. Its bleaching properties are very remarkable, and it may possibly be of considerable practical utility.

Experiments on the Spheroidal State of Bodies, *and its Application to Steam Boilers, and on the Freezing of Water in Red-hot Vessels*, by *Prof. Boutigny*.—Prof. Boutigny, who made his communication in the French language, first proceeded to show that a drop of water projected upon a red-hot plate does not touch it; but that a repulsive action is exerted between the plate and the fluid, which keeps the latter in a state of rapid vibration. At a white heat, this repulsion acts with the greatest energy, whilst it ceases, and the ordinary process of evaporation takes place at a brown-red heat. The temperature of the water whilst in the spheroidal state is found to be only 96°, and this temperature is maintained so long as the heat of the plate is kept up. To bring this water to the boiling point, (212°) it is therefore necessary to cool the plate. These phenomena are explained by M. Boutigny on the supposition that the sphere of water has a perfect reflecting surface, and consequently that the heat of the incandescent plate is reflected back upon it; and some experiments have been made which show that this is the case, the plate becoming visibly redder over those parts on which the vibrating globule played. Several experiments were made in proof of this necessary cooling to produce ebullition. The red-hot plate, with its spheroidal drop, was

removed from the spirit-lamp, and after a minute or two, the water began to boil, and was rapidly dissipated in steam. Ammonia and ether were shown, although so exceedingly volatile, to act in the same manner; the ether, however, being decomposed whilst in the vibratory condition, in the same manner as it is by the action of platina wire, forming a peculiar acid. Iodine put upon the heated plate became fluid, and revolved in the same manner as other fluids, no vapors escaping whilst the high temperature of the metal was maintained; but when allowed to cool to the point of dull redness, it was immediately dissipated in violet vapors. The nitrate of ammonia fused on the glowing hot plate, and vibrated with great energy; but on cooling the capsule, the salt entered into vivid combustion. The repulsive action was shown by plunging a lump of silver at a glowing red heat into a glass of water. As long as its bright redness was maintained, there was no ebullition; but as it slowly cooled, boiling took place. In this experiment, it appeared as if the glowing metal formed around itself an atmosphere; and the contiguous surfaces of the water appeared like a silvered plate. The application of the principles involved in these phenomena to the tempering of metals was then explained. If a metal to be tempered is in a highly incandescent state, the necessary hardening will not take place on plunging it into water. It is, therefore, necessary that a certain temperature should be observed. Experiments were made to show that the repulsive power of the spheroidal fluid existed, nor merely between it and the hot plate, but between it and other fluids. Ether and water thus repelled each other, and water rested on and rolled over turpentine. The bursting of steam-boilers came next under consideration; and it was shown that many serious explosions may be referred to the phenomena under consideration. In a great many cases, the explosions have occurred during the cooling of the boilers after the withdrawal of the fire. An experiment was shown in proof of the view entertained by M. Boutigny. A sphere of copper, fitted with a safety-valve, was heated, and a little water being put into it, it was securely corked up, and withdrawn from the lamp. As long as the metal remained red, everything was quiet; but upon cooling, the cork was blown out with explosive violence. The concluding experiment excited great interest. The production of ice in a vessel at a glowing red heat was a result so anomalous, that every one was desirous of witnessing the phenomenon for himself. It was beautifully performed by M. Boutigny, in the following manner:—A deep platina capsule was brought to a glowing red heat, and at the same moment, liquid sulphureous acid, which had been preserved in the liquid state by a freezing mixture, and some water, were poured into the vessel. The rapid evaporation of the volatile sulphureous acid, which enters into ebullition at the freezing point, produced such an intense degree of cold, that a large lump of ice was immediately formed, and being thrown out of the red-hot vessel, handed round to the company in the Section.

Mr. G. Rennie referred to some experiments of his own, in confirmation of M. Boutigny's views.

On Fizeau's Process of Etching Daguerreotype Plates, *and its Application to Objects of Natural History*, by *Mr. Goadby*.—In a Daguerreotype portrait, the black parts of the plate consist of silver, the white of mercury, and the intermediate tint of a mixture of the two, the degree of darkness or light depending upon the excess either of the silver or of the mercury. In converting a Daguerreotype into an engraved plate, it is necessary to etch away the dark parts and to leave the white untouched. This is done by immersing the plate in a fluid, consisting of dilute nitric acid, nitrous acid, chloride of sodium, and nitrate of potash. The nitric acid is so far diluted, that no decomposition can take place until the mixture is heated, when the chloride of sodium and nitrate of potash are decomposed, and chlorine and nitrous acid are evolved. These attack and remove the silver, or the *dark* portions of the plate, but have no effect on the mercury, so that the *lights* of the picture, being the mercurialized portions of the plate, constitute the *etching* ground, and effectually defend such portions of the Daguerreotype from the influence of the corroding fluid. After a time, those portions of the plate that have been acted upon by the chlorine, &c., become covered with a protecting coat of the chloride of silver: this must be removed by dilute liquid ammonia, when the biting may be continued by a fresh supply of the mixed acid. Grease and foreign matter must be removed by repeated washings in dilute acid and alkali, and by boiling in caustic potash. These cleansing operations must be repeated after every biting, after washing out the chloride of silver by the ammonia. The plate being thus bitten, but in a slight degree, is to be inked after the ordinary manner of engravers, and allowed to dry; the surface of the plate is then to be thoroughly polished, the ink still remaining in the corroded portions of the plate. It is now to be gilded by the electrotype, those parts alone receiving the gold that have been previously polished. The ink is then to be dissolved out of the hollows by potash: the parts that are gilded now constitute the etching ground, instead of the mercury, and the biting may be henceforth continued by nitric acid, in the customary usage of engravers. The plate thus etched, generally requires to be finished by the hand of the engraver, who has the advantage of a *perfect*, although *faint* picture to work upon. The amount of labor which he must bestow will depend upon the goodness of the Daguerreotype, and the success of the etching. M. Claudet has fully established the successful application of this process to the purpose of illustrating Natural History, by copying from Nature and engraving several delicate and difficult dissections of the lower animals, particularly the nervous system of Aplysia and Tritonia (the latter much magnified,) and the nutrimental organs *in situ* of a caterpillar. These preparations, together with the engravings of them, were handed round.

Dr. Carpenter stated, that a similar process had been employed for engraving microscopic objects, the discovery of which was due to Capt. Ibbetson. He exhibited some plates of blood globules, and other microscopic objects published by Dr. Donné, of Paris, which had been procured in this way.

On a New Method of Converting Rectilinear into Rotary Motion, by *Dr. Booth.*—The object of the communication was to show the applicability of a new species of crank, termed by the inventor the *sliding crank*, to the steam engine, more especially in those cases where space is an object of primary consideration. One of the most important improvements effected by this motion is, that the distance between the shaft and the top of the cylinder is only one-half the length of the stroke. Other advantages pointed out in the course of the paper were, that the friction on the sliding parts is nearly insensible; that almost all the parts of the engine have a rotary instead of a reciprocating motion; that all the subsidiary parts of a low-pressure engine are worked with great simplicity; and that in this construction, a longer stroke than in any other of the same dimensions may be introduced, and the expansive principle more fully developed.

Mr. J. Taylor made a few remarks, and observed that the effect of friction on the action of slides, seemed to be in general much overrated.—Mr. Fairbairn observed, that the invention, if carried into successful operation, seemed adapted to work an improvement in marine engines, especially, where room was a matter of great importance, by lowering the position of the machinery, which appeared a great desideratum at the present day. He objected, however, to the difficulty of obtaining free access to some parts of the machinery; the raising of the piston cover, for example, on this construction, would be a laborious operation.

Nasmyth's Steam Hammer for Pile Driving.—This machine has been described at former meetings of the Association. Dr. Greene now read a letter received from Mr. Nasmyth, dated Devonport, in which it was stated that at the first trial with a part of the machine at the manufactory it drove a pile 14 inches square, and 18 feet in length, 15 feet into the ground with 20 blows of the monkey, the machine then working 70 strokes a minute; the ground was a coarse ground imbedded in a strong tenacious clay, performing this work in 17 seconds. The entire machine is now in full action at Devonport for the embankment to be erected there to keep out the sea, and form a wet dock. He describes it as going far beyond what he had dared even to hope for, and that it is truly laughable to see it stick vast 66 feet piles into the ground as a lady would stick pins into her pin-cushion. The entire of the operations required to be performed on each pile from the time it is floated alongside of the stage until it is embedded in the solid foundation of slate rock is only 4½ minutes. The great stage which carries the machine, boiler, workmen, and every thing necessary, trots along on its railway like a wheelbarrow and moves on, the diameter of a pile, the moment it has finished the last. It picks the pile up out of the water, hoists it high in the air, drops it into its exact place, then covers it with the great magic cap, which follows it as it sinks into the ground, then thump goes the monkey on its head, jumping away 70 jumps a minute. At the first stroke the

pile sank 6 feet, its advance gradually diminishing until in the hard ground above the solid slate rock it was reduced to 9 inches. Nothing can better prove the superiority of the principle of this invention, of getting the momentum by a heavy weight moving with small velocity over the same momentum, as got, on the old principle, by a light weight moving with great velocity, than the state of the heads of the piles as driven by each process. Dr. Greene drew attention to a sketch of two heads of piles, one 56 feet long driven by a monkey of 12 cwt., falling from a great height, and making only one blow in five minutes, and requiring 20 hours to drive it; this, though protected by a hoop of iron, is so split and shattered on the head, that it would require to be re-headed to drive it any further. The other, although 66 feet long, was not even supported by an iron hoop, and the head is as smooth as if it were dressed off with a new plane. It was driven with a hammer 50 cwt. and only 3 feet fall, making 70 blows a minute.

Railway Gradients.—Mr. Fairbairn read a communication, the object of which was to show the importance of economizing the first cost of railways, by introducing steep gradients in difficult districts, whereby the expenses attendant upon tunnels, viaducts, and lofty embankments, would be avoided; whilst the author showed that the desired speed might be obtained by increasing the power of the locomotive. Originally, cylinders only of 10-inch diameter had been used, but at the present time, the engines are furnished with cylinders of 14, 16, and 18 inches diameter. The *maximum* speed which had been originally calculated on, was 10 miles per hour, whereas, at the present time, the ordinary speed on the Great Western, with first-class gradients, is 40 miles. The paper was illustrated by many experiments which had recently been made with regard to gradients on the Manchester and Leeds Railway.

Mr. Whishaw confirmed these views by the results of practical experiments to the extent of nearly 4,000 miles, on nearly all the lines of British railways.

Globe of the Moon.—Sir J. Herschell exhibited a model of the globe of the moon in relief, expressing the forms and elevations of its mountains as seen in a good telescope. This beautiful and exquisite work he stated to be the performance of a Hanoverian lady, Madame Witte; modelled by her from actual observation through an excellent Fraunhofer telescope, in a small observatory at the top of her own dwelling-house; the selenographical positions and general contours of the principal craters and other leading features being first laid down on the smooth surface from Messrs. Beer and Maedler's micrometrical measures and charts. The diameter of the model is 12 inches 8½ lines (Reinland measure,) or one 10,000,000th part of the moon's actual diameter. The scale of heights is, however, necessarily enlarged to double this amount, as otherwise the relief would be too low for distinctness. The material is a composition of mastic and wax, and the whole is worked out in such perfection of detail as to represent *every* visible crater and mountain peak—nay, even the minuter lines

of elevation which streak the so-called seas, &c. in their true forms and conventional proportions. In consequence, when properly illuminated, and placed at 30 or 40 feet distance, and viewed through a good telescope, the artificial is scarcely distinguishable from the real moon. The delicacy and precision of the work can only be appreciated by a microscopic examination. In fact, the whole model is stated by Madame Witte to have been executed with the aid of magnifying glasses. Sir J. Herschell accompanied his explanation of this model with several remarks on the physical constitution of the moon in respect of climate, atmosphere, moisture, &c., and compared its surface with the chart of part of Mount Etna, lent him for that purpose by Baron von Waltershausen, and with a drawing of his own of one of the principal craters as seen in his 20-feet reflector—placing the volcanic character of the ring mountains beyond all doubt. By the aid of a large chart by Messrs. Beer and Maehler, several of these, such as Aristarchus, Tycho, Kepler, Copernicus, &c. were pointed out, and their peculiarities described—their places on the model being fixed by the aid of brass circles, representing the moon's equator and meridians. This work, it is understood, will be submitted to the inspection of the Astronomical Society, on the resumption of their meetings in November. Speaking of the climate of the moon, Sir J. Herschell considered as probable the attainment of a very high temperature (far above that of boiling water) by its surface, after exposure to unmitigated and continual sunshine during nearly a whole fortnight. The moon, therefore, when at the full, and for a few days after, must be, in some small degree, a source of heat to the earth; but this heat, being of the nature rather of culinary than of solar heat (as emanating from a body below the temperature of ignition,) will never reach the earth's surface, being arrested and absorbed in the upper strata of an atmosphere where its whole effect will necessarily be expended in the conversion of visible cloud into transparent vapor. The phenomenon of the rapid dissipation of cloud (in moderate weather) soon after the appearance of the full moon (or of a moon so nearly full as to appear round to the unassisted eye,) which he stated himself to have observed on so many occasions as to be fully convinced of the reality of *a strong tendency in that direction*, seemed to him explicable only on this principle.

On the Projection of a Star on the Dark Limb of the Moon, *just before its Occultation. By Pof. Stevelly.*—This the Professor considered to be a result of diffraction. Sir Isaac Newton having observed the shadow of a hair placed in a strong beam of sunlight to be broader than the hair itself, was led to investigate the course of a ray as it passed by the edge of a body, like the edge of a knife placed across a hole in a window-shutter, through which a sunbeam is admitted. At some distance the rays proceeded in their usual straight courses; while he found that, at a certain distance, they were bent towards the edge; but the courses of the nearest rays were bent away from the edge, so as to form curves convex towards it. The undulatory theory enabled us to trace these curves, and they were known to be of the nature of the hyperbola,

with asymptotic branches extending onwards from the diffracting edge. Prof. Stevelly conceived the dark limb of the moon to be such a diffracting edge to the slender beam of light which reached us from a fixed star; and that as the curve was at the last moment the light was allowed to pass convex towards the moon, the portion of the ray which last entered our eye before the star disappeared, being the direction in which we should then see the star, if produced backwards, would meet the moon on her dark surface.

Sir D. Brewster said that if two observers were placed near one another, one will see the phenomenon and another will not. Besides, if it arose from the cause supposed by Prof. Stevelly, it should be observed when the edge of a distant spire or other terrestrial object appeared to pass over a star, which he was not aware had ever been noticed. In his opinion, the cause of it was the light of the star passing occasionally through small spots in the atmosphere, which differed from the surrounding portions, producing an effect on the image of the star something like mirage.—Prof. Challis observed, that if so, the edge of the moon would be rendered discontinuous at that part.—Sir D. Brewster replied, that the new property of the retina which he had described yesterday, supplied an answer to that objection; for it appeared that when two parts of a luminous line were disconnected, the retina filled up the chasm, and rendered the line continuous.—Sir W. Hamilton said he considered it rather favorable to Sir D. Brewster's view, that in some states of the atmosphere, he had observed the edge of the moon notched, particularly when she was near the horizon.

On the Chemical Changes Occurring in Iron Furnaces, by *Dr. Lyon Playfair*, and *Prof. Busen*.—This report went very extensively into the various methods adopted by the authors to insure an accurate determination of all the gaseous products of the hot-blast iron furnaces. It was found that coking was effected in the furnace to the depth of 24 feet. That the distillation of coa reached its maximum at the depth of 14 feet—That the formation of tar took place at between 17 and 14 feet. Hence the coal had to travel 24 feet from the mouth of the body of the furnace to the boshes, to be entirely coked. A great diminution of oxygen is found to occur at those points where the gases become developed, and hence they pass away without undergoing combustion—and it has been estimated that 91 per cent. of the heating material in the form of gaseous products are lost in the hot-blast furnaces. The combustible gases driven off from the furnaces were expelled with a force superior to that used in driving coal gas through the mains for the purpose of lighting towns. These matters having been thoroughly examined—and all the gaseous product submitted to analysis, many of the results being of a very curious character—the authors suggest the propriety of building a canal just above the point at which the gases are given off, for the purpose of conveying these products to other parts where their high heating and illuminating powers may be employed advantageously. These gases in combustion, with a due

supply of oxygen, would give a temperature higher than is necessary for smelting iron; and although the authors do not propose that it should be used for that purpose, they suggest the advantage of employing that waste material for heating steam apparatus—and many manufacturing processes.

On the Manufacture of a Colored Glass, by *M. Splittgerber.* Specimens of glass were exhibited, into the composition of which gold entered as a chloride. These specimens were white, but upon gently heating them in the flame of a spirit lamp they became a deep red, transmitting the red rays of light only. If again the same reddened glass is exposed to the heat of an oxygen blow-pipe it loses nearly all its color, a slight pinkness only remaining. M. Splittgerber considers these results to arise from the oxidation of the chloride of gold in the siliceous compound.

On the Ventilation of Coal Mines, by *Prof. Ansted.*—Prof. Ansted gave an outline of the methods of working coal mines, and then proceeded to narrate the particulars of certain accidents, the circumstances of which seemed capable of suggesting improvements in future; and he referred more particularly to the fact, that, in the Haswell explosion, a considerable number of the persons employed in other panels might have been saved if the communication between them had been more effectually shut off, and if, also, there had been a separate passage or air-drift to the upcast shaft. He also described the explosion in the Killingworth Colliery, where, if the Davy lamp had been in use, the accident would, in all probability, not have happened; and Prof. Ansted urged the necessity of certain conditions being observed in all collieries. 1. That there never should be less than two shafts, because an explosion can scarcely happen without destroying the partition at the bottom of the shaft, and thus checking or entirely stopping the ventilation. 2. That the *panels* should always be of moderate size, and the air-courses never exceed a certain length. 3. That separate air-drifts should always be made from distant workings direct to the pit bottom. 4. The exclusive use of the Safety Lamp in those mines, at least, where the escape of gas from fresh workings, faults, &c., rendered the working at all dangerous.

Prof. Faraday said, the subject of mining accidents had long occupied his attention. The more he pursued the inquiry, the more he was disheartened at the apparent hopelessness of finding out any good general remedy. The explosions were not simply the effects arising from the mixture of gases, but from the combustion of the coal-dust and coal-gas which the first explosion made. In the fatal case at Haswell, the place where the accident originated had been ascertained; and the progress of the fire could be traced on the scorched beams and props of the galleries, and the deposits of coke made from the coal-dust which the explosion raised. To this circumstance the great force of the explosion was due, and not to the first escape of gas. A similar explosion had been known to take place in a cotton-wadding manufactory, the whole atmosphere of the place being fired by means of the particles of cotton in it. Of all the workmen killed in the

Haswell accident, perhaps not one was really burned to death, but suffocated by the *choke-damp*. In one part of the workings the explosion had produced sharp vibrations, like the firing of gunpowder, and in another the burning went on slowly, like a common fire. But although two panels were blown into one, and solid stoppings of brickwork thrown down, there was no indication of the accident in the shaft. If the stoppings had not been blown down, and the supply of air had continued, the mine would have taken fire, and the men been burnt instead of choked. Since the late investigation, Mr. Faraday and Mr. Lyell have had many hundred plans submitted to them, urging ill-considered and contradictory measures. They had examined every part of the Haswell Colliery, accompanied by the mine-viewer, and received recommendations from the best-informed men upon the spot; and they were convinced that the conditions under which the accident happened were so variable, that no general practical rule could be obtained. Far more information, however, was required. The plan of splitting the air-courses was good, as far as the power of the upcast shaft admitted; but, if carried too far, it would produce stagnant points, which could not be prevented by any arrangement consistently with the ever-moving condition of the works. The abolition of the use of gunpowder and lighted candles would, in some cases, double the price of coals. But the great source of danger was the mental condition of the miners. With regard to the present race this was so hopeless, that nothing could be done for them; although smoking was strictly forbidden, they had been known to contrive to light their pipes in dangerous workings even from the Davy lamp; and Mr. Faraday had himself on one occasion sat down with an open candle to watch the preparations for blasting, and when he inquired for the gunpowder was told he was sitting on it. Mr. Faraday took an opportunity, also, of expressing his firm conviction of the safety of the Davy lamp when properly used, and of its being a complete and practical contrivance, to which he would willingly trust his own life, as he had already done on many occasions.

On the Influence of Galvanic Electricity on the Germination of Seeds, by *Prof. E. Solly*.—In a series of experiments, in which the seeds of barley, wheat, rye, turnips and radish were exposed to the influence of a feeble current of electricity, the plants came up sooner and were healthier than others that had not been electrified. On the other hand, a number of experiments on other seeds had given opposite results,—proving, either that the germination of some seeds was retarded whilst that of others was facilitated by electricity, or that the effects observed in both cases were accidental. Out of a series of 55 experiments on different seeds, 21 appeared in favor of electricity, 10 against it, and 25 showed no effect whatever; and in carefully counting the whole number of seeds up in the entire series, there were found 1,250 of the electrified, and 1,253 of the non-electrified. In conclusion, Prof. Solly stated that he felt doubtful whether the effects observed were really due to the influence of electricity. Athenæum.